SEP 15 1961

TRAFFIC ENGINEERING & CONTROL

Transportation Library

Vol. 3, No. 4, August, 1961 Annual Subscription £2 2s. 0d. Single copies 3s. 6d. monthly

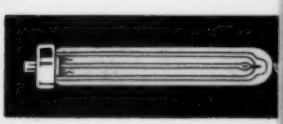
SEP 8 1961
TRANSPORTATION LIBRARY

For really good lighting...

Stella

THE RELIABLE LAMP

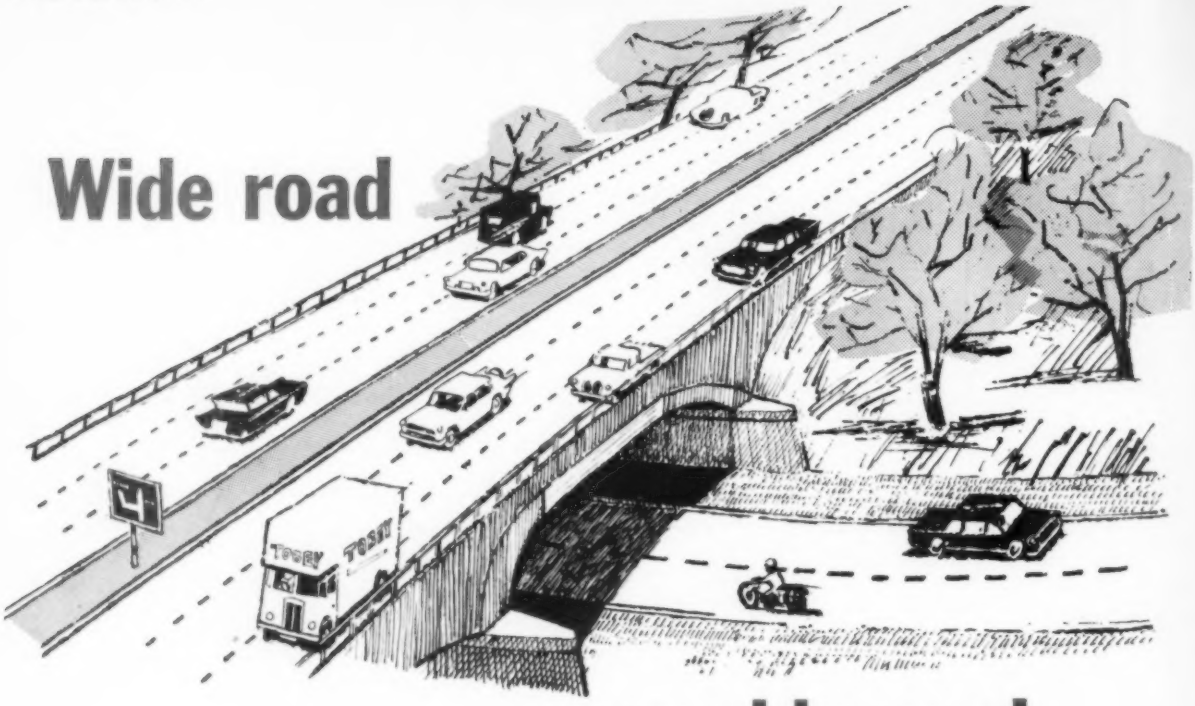
Lighting installation at Herries Roa Sheffield. Stella Sodium Lamps are used in Phosco fittings spaced at 12 and at a height of 25 ft. Photograph reproduced by kind permission of C Chisholm, Esq., F.I.E.S., Public Lig ing Engineer, Sheffield Corporation.



STELLA LAMP COMPANY LTD
158/160 SHAFTESBURY AVENU
LONDON · WC2

TEC563 for further information

Wide road



or side road

There's always a 'VISQUEEN' UNDERLAY the right width

'Visqueen' speeds work on motorway
Seamless 26-foot wide 'Visqueen' sheeting being laid by machine on one of the dual concrete carriageways of Contract 2 on the St. Albans by-pass section of the London/Yorkshire Motorway.
Agent Authority: Hertfordshire County Council.
County Surveyor: Lt. Col. C. H. ffolliott, B.A., M.I.C.E., M.I.Mun.E.
Contractors: The Cubitts-Fizpatrick-Shand consortium.

'Visqueen' saves time on service road
A roll of 'Visqueen' underlay being unreeled by hand. The sheeting can be laid quickly in position with the minimum of effort.

'Visqueen' is quicker to lay and easier to handle, whether by hand or by machine.

Whatever the bay width, you can always be sure of obtaining a 'Visqueen' polythene underlay *the right width for the job*. In fact, for road projects involving extra-wide bay widths, 'Visqueen' underlays can be tailor-made to specific requirements.

That is not the only reason why more and more Local Authorities are specifying 'Visqueen' Building Sheet for their road building programmes both as an underlay and as a curing blanket. They know that many contractors prefer 'Visqueen' to other underlay materials, because it is quicker to lay and easier to handle. It doesn't run or shatter, it's completely waterproof and resistant to sulphate attack.

Standard rolls of 'Visqueen' up to 12-foot wide (centre folded) can be obtained from appointed stockists.

To find out how the many applications of 'Visqueen' can help to speed up work on your contract, write now for an illustrated brochure, price list and samples to:

BRITISH VISQUEEN LIMITED

SIX HILLS WAY, STEVENAGE, HERTS. TEL: STEVENAGE 1310

A subsidiary company of Imperial Chemical Industries Limited.

BV144

TRAFFIC ENGINEERING & CONTROL

Incorporating TRAFFIC MANAGEMENT

VOLUME 3 No. 4 AUGUST 1961

The only British monthly devoted exclusively to traffic engineering.

Editor
ERNEST DAVIES

Editorial Advisory Board
SIR WILLIAM G. HOLFORD
SIR WILLIAM BLACK
PROF. W. FISHER CASSIE
WILFRID ANDREWS
CHRISTOPHER T. BRUNNER

Editorial Consultants

Lighting
GRANVILLE BERRY

Parking
CONRAD ANDREN

Signs and Markings
K. SUMMERFIELD

Road Safety
BRIG. R. F. E. STONEY

Industrial News Editor
N. A. KELLY

Advertisement Director
ERIC G. DAVIES

Advertisement Manager
A. G. D. SOAMES

Circulation Manager
E. M. CLARKE

Traffic Engineering & Control is published by Printerhall Limited, 34-40 Ludgate Hill, London, E.C.4, City 1755/6/7, and printed at The Grange Press, Southwick, Sussex.

The entire contents are protected by copyright in Great Britain and the Universal Copyright Convention, but matter may be reproduced provided that due acknowledgment is made, except for complete articles, in which case application should be made to the Editor.

Annual Subscription £2. 2s. 0d. post free (single copies 3s. 6d.) United States and Canada $7. All other countries £2. 10s. 0d. sterling.

CONTENTS

Editorial Opinion 213

Topics of the Month 215

FEATURES

Edinburgh Region Traffic Survey 216
G. M. Dickson

Perth's Narrows Bridge and its Approaches 222
D. J. Davies

Assistance for Roads in Under-Developed Countries 226
Christopher Brunner

Traffic Aspects of Urban Intersections 230
Hanskarl Schreiner

DEVELOPMENTS ILLUSTRATED 234

Central Business District Land Use and Traffic Generation . . . 236
H. M. Edwards and B. C. S. Harper

Courses in Traffic Engineering—Hatfield College of Technology . . 243
G. J. Hussey

Letter to the Editor 243

Tottenham Court Road One-Way Traffic Area 244

Lighting Section—Glass Fibre Street Lighting Columns 247
E. H. Austin

Parking Section—Community Parking Programme 250
James B. Sagg

Industrial News 252

TEC577 for further information

ELLIOT STREET

Gt CHARLOTTE STREET

TYPE 54 IN ACTION AT LIVERPOOL

GT. CHARLOTTE STREET—ELLIOT STREET

Liverpool has just installed yet another Type 54 controller. This latest application of Type 54 is the City's first use of road signal control for the recently initiated system of one-way traffic round the main approaches to the Mersey Tunnel: a four-lane traffic stream along Elliot Street is crossed by the three-lane stream along Gt. Charlotte Street. Much of Liverpool's through traffic passes this inter-section and is being dealt with swiftly and safely by the Type 54 controller.

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD. STROWGER HOUSE, ARUNDEL STREET, LONDON, W.C.2. Tel: TEMple Bar 9262

ATE

ELECTRO-MATIC
VEHICLE ACTUATED
ROAD SIGNALS

AT10361

Transport out of Balance

PUBLICATION of the British Transport Commission's annual report and accounts, showing for 1960 a deficit after central charges of £101 million, and the submission of a supplementary estimate to Parliament to enable the estimated anticipated deficit for 1961 of £130 million to be met, against the original estimate of £101 million, reveals how out of balance is the country's transport system. The operating loss of British Railways was £57.7 million, but the Commission's road services, bus and coach and road haulage, had an operating surplus of approximately £13½ million. Railway assets are valued in the accounts at some £1,718 million. The modernization programme, originally estimated to cost £1,200 million, continues. There must be something wrong with a transport system, which, on so great an investment—past and contemplated—in the larger section, is greatly under-employed and operates at so great a loss, and the other is congested and costly but none the less found more economic for the greater proportion of the country's goods transport. Both in a sense can be regarded as wasteful.

One explanation of this unbalance is the lack of transport planning: the transport system is not viewed as a whole, but each of the forms which make it up is considered in isolation and is operated independently. Under free competition, which has been the aim of government policy during the last ten years, no one has had responsibility for taking a long-term view or deciding how the transport system should be organized so that it can be employed most economically. In effect, one can look in vain for a transport policy. This need not be a political question, a matter of rival doctrines between free enterprise and public ownership, as that is no longer in dispute for the railways, nor between competition and co-ordination, which is a matter of organization and administration. It is a matter of economics not politics.

In regard to both road and rail, the respective administrations are no doubt doing their utmost, within the resources available to them, to get the most economic use out of both, but they cannot decide on transport policy. Nor, under competitive conditions and subject to certain price controls, are they necessarily able to charge economic prices for their services. Even were they permitted to do so however, the position would not necessarily be much improved; in fact, the railways' deficit might grow with the loss of further traffic to the roads.

This problem of the use to which the various forms of transport are put has been exercising the transport experts in the United States, where a greater degree of motorization, combined with a vast expenditure on roads, including expressways into the cities, has led to a serious deterioration in public transport. It has in fact become very much the concern of traffic engineers, and the traffic studies in the major cities, including Chicago, Pittsburgh, Washington, San Francisco, Los Angeles, Detroit and St. Louis, have paid much attention to this issue. In nearly all cases such studies have resulted in recommendations regarding the provision of public services, rail and road as well as less conventional forms. In this country traffic engineering has perhaps tended to confine itself overmuch to the roads. It is, no doubt, largely because it has developed as a branch of civil engineering and the traffic engineer has been regarded more as a road traffic specialist. In view of the fact that some 90 per cent of those travelling to work daily use public transport, and great numbers still commute by rail, the solution of the traffic problems of urban areas can no longer be solely looked for in the relief of road congestion, by construction and improved traffic control to raise capacity and ease flow. The provision of alternative forms of transport is of equal importance. London, with its peak hour congestion of all forms of transport, provides a good example. The solution to its problem can by no means reside merely in raising the capacity of its roads but may be found also in the provision of greater facilities for public transport as, for instance, by taking some of the load underground. The building of the Victoria Line might well relieve congestion in the centre far more than the removal of a number of bottlenecks. But no decision on its construction has yet been taken because, presumably, no one has been responsible for deciding whether the expenditure of £55 million on its construction would relieve traffic more than the same expenditure on new road construction.

Far more study and research is needed in regard to transport planning, but unfortunately it appears little is being done, or if it is, little is known of it. This is no doubt because, apart from the government itself, no one can take decisions in regard to transport policy as a whole, and the Ministry, by and large, tends to take a short-term view. Because of the importance of looking at transport as a whole, and because it should be at least partly the responsibility of the traffic engineer, it is proposed also to cover this aspect of the transportation problem in the pages of this Journal in the coming months. The first of such articles describing transportation planning in the Pittsburgh region will be published next month.

car park FULL

CAR PARK FULL ! . . . the sign that every car park owner wants to put up.

Since the opening, the new municipally owned Bedford multi-storey car park has run smoothly and economically and has repeatedly been filled to capacity, exactly as planned by the Borough Engineer & Surveyor, F.W. Dawkes, B.Sc., A.M.I.C.E., M.I.Mun.E., A.M.T.P.I.

Holst & Company Limited as Civil Engineers are pleased to design to meet your requirements and to create structures that will satisfy your needs.

HOLST

46 CLARENDON ROAD · WATFORD · HERTS.

Telephone: **WATFORD 34481**

BIRMINGHAM MANCHESTER LEEDS DURHAM EDINBURGH CARDIFF

Topics of the Month . . .

THE terms of reference given by the Ministry of Transport to the Steering Group, recently appointed to assist Mr. Colin Buchanan in his task as long term planner of urban transport and its reconciliation with land use, are worthy enough, as are its members. Sir Geoffrey Crowther is its Chairman and the rest of the team comprises Sir William Holford, President of the R.I.B.A., Mr. O. A. Kerensky, partner in the firm of civil engineering consultants responsible, with their American associates, for the Greater London Traffic Survey, Mr. C. H. Pollard, City Treasurer of Hull, Councillor T. D. Smith, concerned with urban redevelopment in Newcastle upon Tyne and Mr. Henry Wells, Chairman of Hemel Hempstead Development Corporation. The team is well representative of the chief professions concerned with urban planning, well experienced in planning or executing modern ideas in the field and should be fully competent to lay down the principles which should govern the provision for motor transport in urban areas. These are its main concern and include, according to the Ministry's announcement, the nature and probable cost of measures required to accommodate transport, the time required to implement them, and their compatibility with other needs of towns, such as the avoidance of urban spread, the economical use of land and good environment. The Group's purpose is to keep itself informed of how Mr. Buchanan's work is progressing, to advise him on broad lines and advise the Minister on his conclusions.

The main problem is to reconcile long-term urban planning with transport planning, that is land use and traffic. The task is urgent because large areas of our towns and cities are due for redevelopment and guidance is essential. It has been far too long withheld —or based on outmoded thought. It is to be hoped that the appointment of the Steering Group will enable this to be speedily produced and that it will in no way delay Mr. Buchanan's study of long-term needs or tie his hands unnecessarily. He has already proved himself competent to fulfil his task unaided.

Rural Road Design Standards

IN its new memorandum on the design of roads in rural areas, the Ministry of Transport is being most conservative in its provision for the growth of motorization. It recommends that for long-term planning the 5 per cent growth rate should be assumed for a minimum period of 20 years, or say, 150 per cent increase over 1959 traffic problems. This is a considerable advance on the previous figure of 75 per cent over the 1954 figure but, if American experience is to be repeated here, this volume will be reached long before 1971. Quite rightly the Ministry draws attention to the need to give due weight to the probable economic life of the layout of roads, in view of this anticipated growth, and has fixed improved standards to meet it. Briefly, the more important are that:

Two-lane carriageways should be designed for 6,000 passenger car units per 16-hour day, three-lane carriageways for 11,000; dual two-lane carriageways for 25,000, and dual three-lane carriageways for over 25,000. Traffic lanes should have a width of 12 ft. on trunk and important classified roads, except on three-lane carriageways when an overall width of 33 ft. should normally be used. On dual-carriageways, breaks in the central reserve should not be provided for U-turns and should be restricted to road junctions.

For trunk and classified roads on new alignments in rural areas, verges should have a minimum width of 12 ft., of which 4 ft. adjacent to the carriageway should be kept clear of footpaths and all obstructions throughout the length of the road. The 12 ft. dimension can be reduced to 9 ft. on and under bridges.

Design speeds on new and improved dual-carriageways should be 70 miles an hour; 33 ft. single carriageways and trunk and Class I single 24 ft. carriageways, 60; and other classified roads with two-lane single carriageways, 50 miles an hour.

Road Safety Research

THE first ten months research by the Road Injuries Research Group, which has the financial support of the A.A., was completed in April 1961 and the findings are published in tabulated form in its first report, with comments and suggestions. Only serious accidents were studied and special attention given to fatalities. The work has been entirely concentrated on the medical aspects of personal injuries and their causes; not to any degree was consideration given to the conditions of the road nor was traffic engineering part of the study. It was by analysing the extent and type of injuries received by car occupants, pedestrians, cyclists and motor cyclists, and by the study of the bodily positions of these injuries, that the group was able to suggest alterations which should be made to the design of cars and goods vehicles.

The first conclusion of the research directors, Dr. William Cussane and Dr. John Bull, was that many of the accidents would not have happened had traffic been segregated, the roads more adequate for the demands of volume and speed, or more care exercised by those involved. However, they were not so much concerned with the causes of the accidents, but with the causes of the injuries and, in the case of pedestrian involvement, segregation appears the only solution. The report concludes that the use of helmets and other protective clothing is the most promising hope in an unpromising situation. In the case of the occupants of private cars, though, and in the improvement of the design of commercial vehicles, there is a much better prospect of providing greater protection.

That such work is badly needed in this country, if it can contribute to a reduction in road accidents, fatalities and injuries, is evidenced by a comparison between accident figures in the United States and Britain, prepared by RoSPA. These show how much room there is for preventive work based on research. Although the figures are not strictly comparable, and it must be remembered that here there is a greater car population to road mileage—21 per mile in U.S.A. compared with 49—the United States figures per motor vehicle-mileage and number of vehicles are less appalling than in this country. Where in the U.S.A. road deaths were 5.2 for every 10,000 vehicles, they were 7.4 here and for every 100 million motor vehicle-miles 5.3 and 9.7 respectively.

Photo: Scotsman Publications.
Fig. 1. Congestion at the west end of Princes Street, Edinburgh.

EDINBURGH REGION TRAFFIC SURVEY

by G. M. DICKSON

A.M.I.C.E., A.M.T.P.I., A.M.Inst.H.E.,
City Engineer's Office, Edinburgh Corporation

EDINBURGH is a city of nearly half a million population. It is bounded by the sea on the north and by hills on the south. Therefore the major lines of communication are on the east-west axis. Princes Street lies in the centre of the city on the east-west axis and 13 main radial roads gather the traffic and converge upon the two ends of Princes Street. Maximum traffic densities for the city occur at the west end of Princes Street. A proposed route for a by-pass road to Edinburgh has existed for many years and when the Development Plan was approved in 1957, the by-pass proposal was included, but programmed in the period beyond 20 years. Soon after the publication of the Development Plan, the Government announced their approval to the construction of the Forth Road Bridge. The idea of having this magnificent bridge, with the third largest span in the world, on the doorstep of Edinburgh produced much speculation about the effect that this would have upon the traffic problem in the city, and particularly in Princes Street. (See Figs. 1 and 3.)

There was the conception of an enormous amount of traffic in a vague way related to the size of the bridge. Opinion was expressed in the local press and elsewhere that the city by-pass should be constructed at an early date, and it became necessary to have facts, so that the whole question of traffic entering and leaving the city could be put into perspective.

Therefore the main object of the survey was to find out the origin and destination pattern of traffic on the main radial roads, which would provide essential data required for the planning of future highways in the area, with particular reference to the proposed Edinburgh by-pass. The survey took place on the 13 principal roads entering the city and was carried out during the week commencing Monday, June 27, 1960. The date was chosen to avoid events such as the Highland and Agricultural Show and the local trades holidays, which upset the normal pattern of traffic, and also for a period when the necessary temporary staff could be recruited. The actual date of the survey was not disclosed in advance in case traffic would have deliberately avoided the census points.

On the roads entering Edinburgh, survey stations were selected on the approximate line of the proposed by-pass road, as indicated in the Edinburgh Development Plan. Pilot surveys were carried out in the early part of the year to obtain data to assist in the planning of the survey.

The work of the survey fell into four main parts:

(i) Planning and preparation.
(ii) Field Work.
(iii) Analysis.
(iv) Interpretation and Report.

All these stages covered a period of several months, but the field work only required a few days.

The success of a survey of course depends upon the thoroughness and efficiency of the planning and preparation and adequate time spent at this stage is essential. In this case, about six months elapsed between the decision to carry out the survey and the actual date of the field work. Early consultations took place with all the various departments concerned, and one of the first things which had to be settled was the actual date of the survey.

The method employed was to question, by direct interview, as many drivers as possible of the inwards to Edinburgh traffic. Public service vehicles and pedal cycles were not stopped. A technique developed

Fig. 2. Interviews in progress.

by the Road Research Laboratory of random sampling was used in order to reduce the delay to vehicles to a minimum. Two or three interviewers were in operation at a time, the number varied according to the volume of traffic. The interviewers were kept fully engaged and traffic not required for immediate interview was allowed to pass. There was no selection of the vehicles and as soon as the interviewer was free, the police officer directed the next approaching vehicle into the interview bay.

The overall pattern of traffic entering the city on a single day was required and one method would have been to have had all the points surveyed simultaneously on the same day. This presented staffing and administrative difficulties and so the period was extended over five days and three points were surveyed each day.

The survey was carried out for a period of 16 hours (6.0 a.m. to 10.0 p.m.) at each census point. A basic group of six persons was on duty during each shift, there were two shifts per day, therefore each point required twelve persons per day and, in order to cover three points each day, a total of 36 persons was required. The census points were

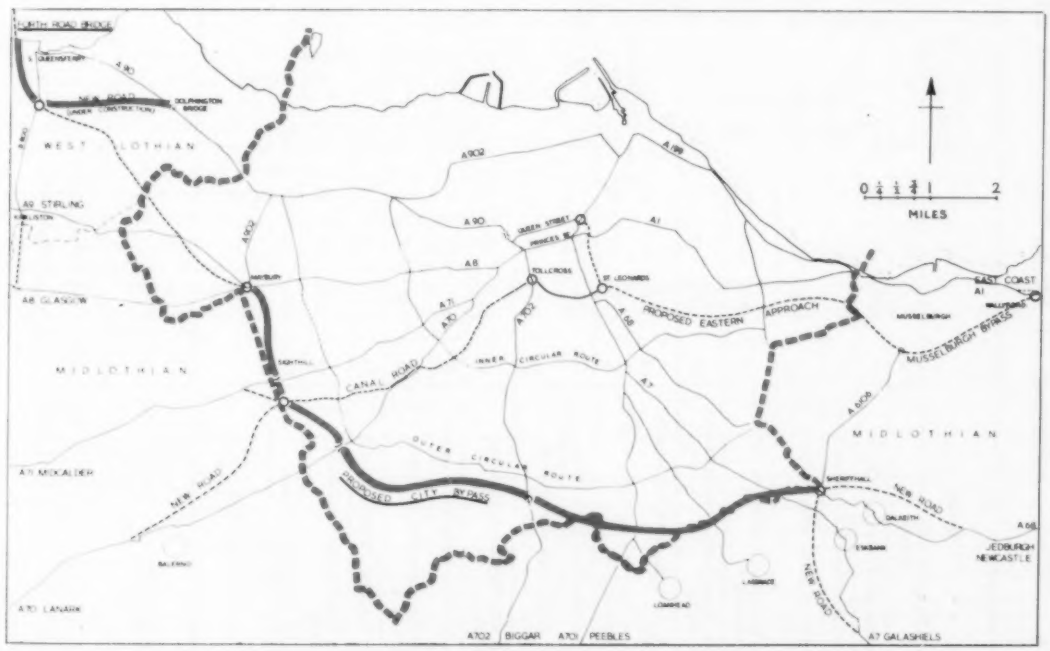


Fig. 3. The position of the Forth Road Bridge relative to Edinburgh and to the major road proposals for the city and the region.

Fig. 4. **ANALYSIS OF FINAL DESTINATIONS BY DISTRICTS OF ORIGIN** (No. of vehicles in sample for 16 hours)

ORIGIN		FINAL DESTINATION																									
		Edinburgh									*Other than Edinburgh*																*Totals*
District	*Code*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Musselburgh, Tranent, Dalkeith.	10	905	662	196	304	179	680	248	97	178	2	32	64	3	2	79	34	3	2	7	93	9	12	8	1	3,800
Penicuik, Rosewell, Roslin, Loanhead.	11	492	236	61	217	132	73	165	147	143	31	—	42	3	1	42	14	5	—	2	54	9	2	6	2	1,879
Queensferry, Kirkliston, Ratho, Balerno.	12	778	506	95	235	412	80	52	249	664	77	69	6	38	22	20	19	2	21	10	9	—	1	8	36	3,409
North Berwick, Haddington, Gifford, Pencaitland.	13	293	216	39	98	101	101	32	27	56	12	5	22	—	3	21	14	—	—	4	41	4	6	4	—	1,099
Lauder, Stow, Peebles, West Linton, Carnwath.	14	175	75	15	68	52	17	15	31	52	8	1	17	—	—	9	6	—	—	—	10	4	1	6	—	562
West Calder, Bathgate, Linlithgow, Falkirk.	15	562	451	59	135	264	75	30	63	343	100	50	21	44	9	2	—	16	18	2	2	1	—	4	45	2,296
Fife, Kinross.	16	182	131	20	41	47	27	14	23	60	22	14	5	14	6	—	—	5	11	3	2	—	—	—	67	694
East Scotland, including Duns.	17	64	33	7	15	24	14	6	10	17	1	—	6	—	—	6	8	—	—	2	11	2	2	3	—	231
South East Scotland, including Borders.	18	107	62	17	28	49	15	10	9	23	4	1	8	1	—	11	14	1	1	2	16	4	12	6	—	401
South West Scotland, including Dumfries.	19	113	72	17	34	37	10	9	21	38	12	1	8	3	—	3	5	2	—	—	4	2	2	4	2	399
West Scotland, including Glasgow.	20	531	387	70	98	143	61	32	49	203	120	51	21	60	7	4	5	12	17	3	1	1	3	3	76	1,958
North West Scotland, including Stirling.	21	157	59	9	19	34	12	9	9	33	19	3	—	6	3	—	1	1	8	2	1	—	—	—	45	430
North Scotland, including Perth	22	155	76	14	42	22	14	9	13	49	17	4	—	11	6	3	—	2	15	2	2	—	—	—	110	566
North East Scotland, including Dundee.	23	65	67	14	15	26	10	2	16	36	9	7	5	6	2	1	—	3	10	2	3	—	—	—	66	365
England, including London.	24	250	94	18	36	38	38	16	20	43	4	—	14	—	1	25	53	1	2	2	89	22	62	79	2	909
TOTALS		4,829	3,127	651	1,385	1,560	1,227	649	784	1,938	438	238	239	189	62	226	173	53	105	43	338	58	103	131	452	18,998
		16,150									2,848															

DESCRIPTION OF EDINBURGH DISTRICTS

1. Central Square Mile.
2. North, including Leith and Granton.
3. Restalrig, Duddingston, Prestonfield.
4. Newington, Grange, Craiglockhart.
5. Gorgie, Ravelston, Blackhall.
6. Portobello, Craigmillar.
7. Gilmerton, Liberton.
8. Fairmilehead, Colinton.
9. Sighthill, Corstorphine, Silverknowes.

chosen in such a way that a vehicle had to pass one of the points in order to enter the city. In addition, a total count of both inwards and outwards traffic was taken and classified into vehicle types.

The census being carried out is shown in Fig. 2 and a specimen of the census form used for the interviews is shown in Fig 6. The questions were kept as short and as simple as possible in order to avoid the need for any explanation.

Analysis

When the completed census forms were returned to the office, the information had first to be coded, the answer to each question being given a separate code number. This coding was an extensive task, and several of the enumerators who had been engaged upon the survey were retained in the office for this work. The data had to be transferred to punched cards, one card being used for each interview: the information on the cards was then analysed on the punched card equipment. Analysis of the information collected was made on the following charts:

Traffic Classification.
Traffic Flow each hour.
Sample size.
Final Destinations by census points of origin.
Final Destinations by districts of origin.
Final Destinations other than Edinburgh by need to visit Edinburgh.
Traffic passing through central area by census points.
Origins by distance from Edinburgh.
Use of private cars (i.e. business, to or from work, pleasure).
Public Service Vehicles by census points.

The total figures show that on a typical week-day in mid-summer, between the hours of 6 a.m. and 10 p.m., some 32,000 vehicles enter the city, and a similar number leave the city on the principal roads.

Sampling factor

The actual total of in-bound traffic recorded was 32,786 vehicles. Pedal cycles and public service vehicles were not stopped, and this reduced the total amount of in-bound traffic which it would have been possible to interview to 30,498 vehicles. Out of this total, the drivers of 18,998 vehicles were in fact interviewed, an overall sample of 62 per cent.

The analysis of sample size shows how the sample varied between each class of vehicle and at each census point. The number of cars interviewed was a little above the average of 62 per cent, and the number of light vans and two-axle lorries was a little below this average. For the purposes of computation a sampling factor of 0.6 was adopted.

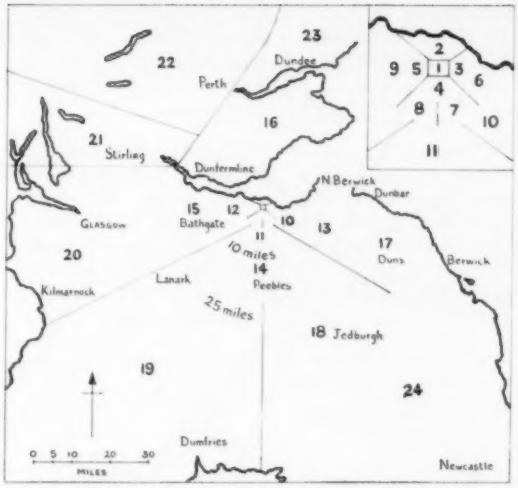


Fig. 5. Diagram of region showing zones used for analysis.

Interpretation

The next stage of the work was to make a detailed study of the various charts produced in the analysis. The analysis zones which were used for the coding of the information on the census forms are shown in Fig. 4 (Analysis Chart) and Fig. 5 (Analysis Zones).

Origins

All the traffic with which the survey was concerned had its origin outside Edinburgh. The following table shows the general distribution of its origin:

Within 0-5 miles	48.0%	68.7%
Within 5-20 miles	20.7%	
Over 20 miles (south Scotland)	15.7%	
Over 20 miles (north Scotland)	7.2%	
Fife & Kinross	3.6%	
England	4.8%	
	100.0%	

Of all the traffic entering Edinburgh, 68.7 per cent had its origin within 20 miles of the city boundary.

Motor Cycle or Scooter	Private Car: Pleasure	Private Car: Business	Private Car: To or from work	Light Van (Car Chassis)	Lorry or Heavy Van (2 Axles)	Lorry (3 or more Axles)	Touring Coach	ORIGIN-DESTINATION CENSUS				DAY		DATE									
								Survey Station				Hour: From		To									
								Interviewer				Station Code				Hour Code							
												For Destination IN EDINBURGH				For Destination OTHER THAN EDINBURGH							
								Where did you Start Your Journey	Code	Is Your Final Destination Edinburgh	Code	District or Street	Code	Through Princes St or Queen St.	Code	What is Your Final Destination	Code	Do You Need to Visit Edinburgh	Code	Through Princes St. or Queen St.	Code
1	2	3	4	5	6	7	8																

Fig. 6. Example of the census form used in the Edinburgh region traffic survey June 1960.

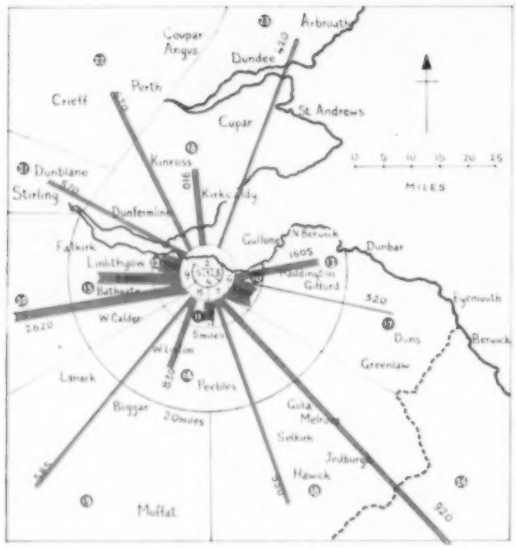


Fig. 7. Traffic with final destination Edinburgh. Circles denote zone reference numbers. Other figures are vehicles per 16-hour day.

Destinations

The following table shows the general distribution of the destination of traffic.

Central Square Mile	26.0%	
North Edinburgh	17.0%	
West Edinburgh	18.0%	92.8%
South Edinburgh	15.0%	
East Edinburgh	10.0%	
Not Edinburgh (but need to visit)	6.8%	
Not Edinburgh (no need to visit)	7.2%	7.2%
		100.0%

Traffic which had a final destination in Edinburgh or required to visit Edinburgh amounted to 92.8 per cent of the total.

Fig. 7 shows a diagram of this traffic. The remaining 7.2 per cent had a final destination outside Edinburgh and did not require to visit the city. Fig. 9 shows a diagram of this traffic.

By-passable Traffic

The potentially by-passable traffic is contained in the group of 7.2 per cent i.e. traffic having a destination outside Edinburgh and not requiring to visit the city. By a study of the analysis information, the following conclusions were reached about this traffic:

Vehicles entering and leaving the area by adjacent roads	0.6%
Vehicles which would use only part of the by-pass	2.3%
Vehicles which at present travel through the central area	1.8%
Vehicles which would use the full length of the by-pass	2.5%
	7.2%

Therefore only 2.5 per cent of the traffic would use the full length of the by-pass, but if the 1.8 per cent at present travelling through the central area were to transfer to the by-pass route, then this would make a total of 4.3 per cent using the full length of the by-pass. In terms of traffic figures this amounts to an average flow of 89 vehicles per hour.

Edinburgh-bound Traffic on the By-pass

From a study of the traffic pattern it is apparent that some of the traffic travelling into certain parts of Edinburgh would be able to make some use of the by-pass if it existed on the route as shown in the Edinburgh Development Plan. This is not, however, the category of traffic for which the by-pass would be primarily constructed and much of this traffic may have a satisfactory existing route which it would continue to use in any case. However, figures can be extracted from the analysis charts to show that in this category of traffic some 1,970 vehicles in the sample might make some use of the by-pass if it existed, and that 550 of these vehicles might be expected to use the full length of the road. Only inbound traffic was interviewed, but traffic on a highway is normally stated in terms of vehicles per hour in both directions, therefore, in assigning this traffic to the by-pass, these figures for traffic which had its final destination in Edinburgh must be doubled on the assumption that the pattern of out-going traffic was similar to that of the incoming traffic. Therefore if all the 550 vehicles transfer to the by-pass, this would amount to:

$550 \times 2 = 1{,}100$ vehicles in both directions (sample figures).

$\frac{1{,}100}{0.6} = 1{,}833$ vehicles per 16-hour day.

$\frac{1{,}833}{16} = 114$ vehicles per hour (average).

The remainder of this traffic, $(1{,}970—550) = 1{,}420$ vehicles, might use part of the by-pass. On the assumption that all of this traffic would transfer to the new road, this would amount to:

$1{,}420 \times 2 = 2{,}840$ vehicles in both directions (sample figures).

$\frac{2{,}840}{0.6} = 4{,}733$ vehicles per 16-hour day.

$\frac{4{,}733}{16} = 296$ vehicles per hour (average).

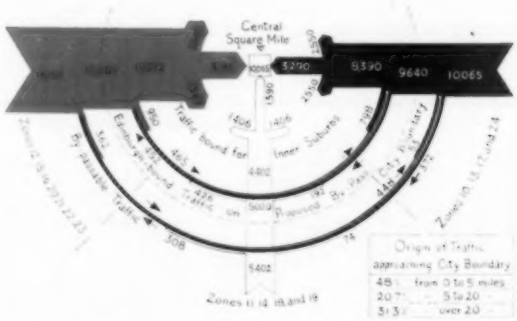


Fig. 8. Diagram showing relative proportions of Edinburgh-bound traffic and by-passable traffic. Figures denote vehicles per 16-hour day.

Owing to the fact that much of this traffic may have satisfactory existing routes and that suitable points of interconnection with the new road would be limited, it is unlikely that any more than half of the traffic which might make part use of the by-pass would, in fact, be attracted to use it. Therefore, the Edinburgh-bound traffic which might use the by-pass amounts to 114 v.p.h. (average) for the full length, and 148 v.p.h. (average) for a part length.

The survey confirmed that the pattern of traffic in the Edinburgh area was similar to that of other cities of comparable size in so far as only a small proportion of the total traffic entering the city was found to be by-passable. It was apparent that a large proportion of traffic wished to penetrate far into the city and that more information would have to be collected regarding the complex nature of the traffic in the central area.

ACKNOWLEDGMENTS

W. P. Haldane, M.B.E., B.Sc., M.I.C.E., M.T.P.I., City Engineer, Edinburgh, for permission to prepare this paper; and for advice and technical assistance to: Chief Road Engineer, Scottish Home Department. Road Research Laboratory, Thorntonhall, Dr. T. E. H. Williams, Durham University. Organization and Methods Service, Edinburgh Corporation. Chief Constable, City of Edinburgh.

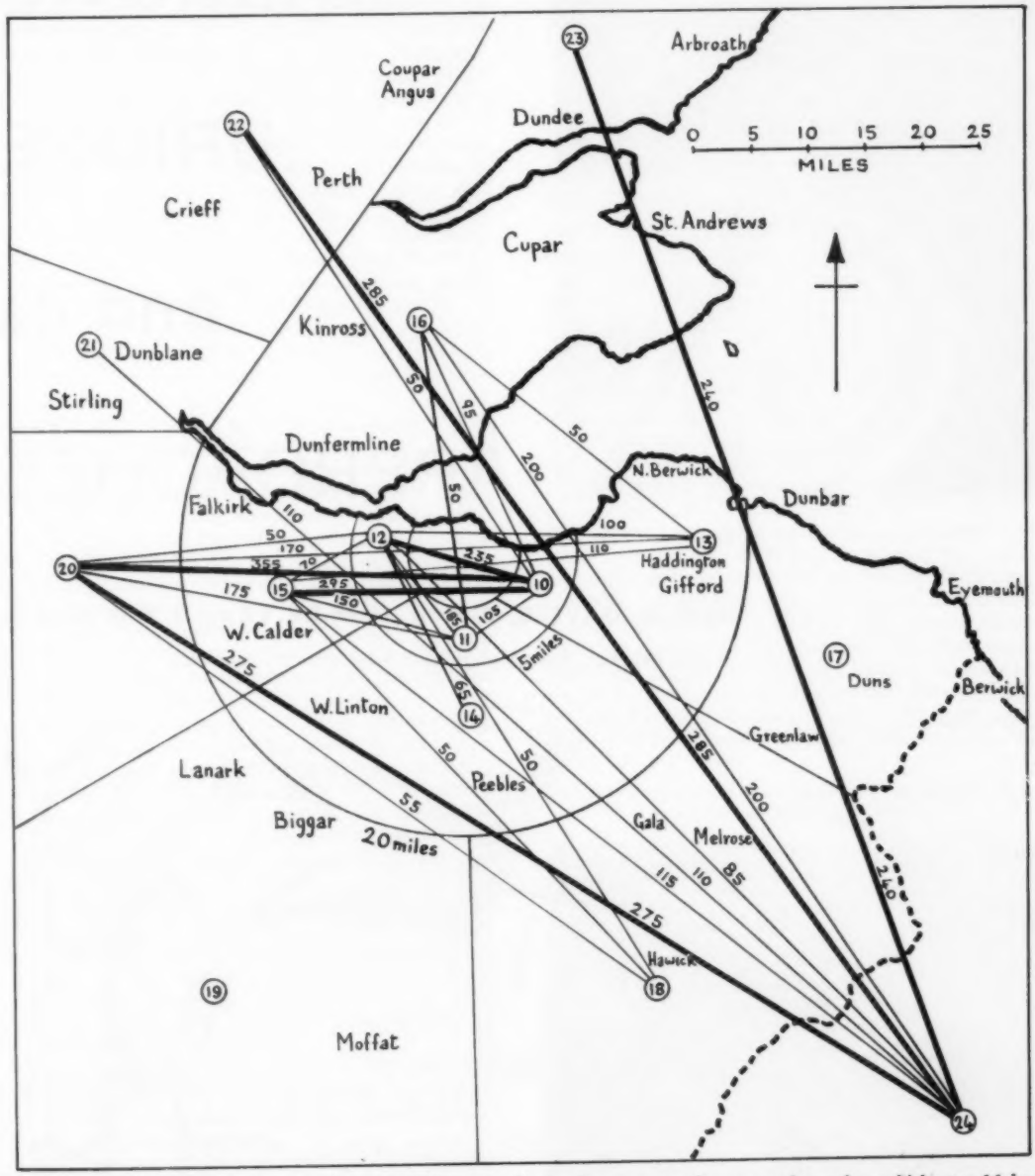


Fig. 9. Traffic with final destination other than Edinburgh. Circles denote zone reference number, other vehicles per 16-hour day. Movement between zones of under 200 vehicles per day are indicated by a single line only, under 50 vehicles per day are not indicated.

PERTH'S NARROWS BRIDGE and its APPROACHES

Fig. 1. Aerial view of the Narrows Bridge.

by D. J. DAVIES, B. Eng., A.M.I.E. (Aust.), A.M.Inst.T.,

Traffic Engineer, Main Roads Department, Western Australia.

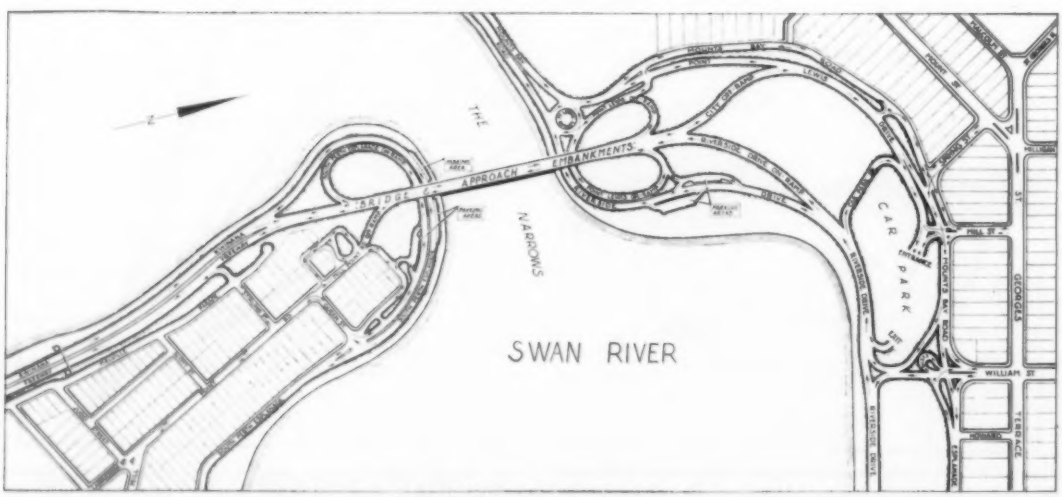


Fig. 2. Diagrammatic layout.

Australian Report

THE area defined in the West Australian Traffic Act as the Metropolitan Area of Perth extends along the west coast of Australia approximately on the 32° parallel of latitude for a distance of about 42 miles. It varies in width from 23 miles at its northern boundary to approximately six miles at the southern boundary. The area is bisected by the Swan River which discharges into the sea at Fremantle, some 14 miles south of the northern boundary of the area. The Swan River estuary extends some 15 miles inward from the river mouth and the city centre of Perth, the State capital, is located on the north bank of a section of river which is wide and estuarian in character, a situation of considerable charm and beauty. Perth Water, on which the city fronts, is approximately one mile wide and 1½ miles long, lying between the Narrows on the west and Heirisson Island on the east. Upstream from Heirisson Island the river banks close in, while downstream from the Narrows the river opens to a width of 1½ to 2 miles, in Melville Water, before reaching the sea through a comparatively narrow outlet at the Port of Fremantle. The situation is such as to require the most serious consideration of the aesthetics of the bridge and its ancillary highway structures.

The central business district is bounded on the west side by King's Park, a public open space nearly one square mile in area, which rises in a steep bluff from the river at the Narrows; on the south and east sides by the Swan River; and on the north side by the main railway line connecting Fremantle with the city and the hinterland. Up to the present the severance caused by the railway has discouraged business development northwards on any large scale, although there is much business activity immediately north of the railway of a relatively minor nature.

The central business district has a length on an east-west axis of roughly two miles, while its minimum width between the river and the railway is only about half a mile. The Metropolitan Regional Plan, which has been substantially adopted, will provide ultimately for four major radial roads connected by an inner ring road of freeway standard approximately following the boundaries of the central business district. The completed work is illustrated by the aerial photograph Fig. 1. The diagrammatic layout is shown in Fig. 2. Three of the four major radials will approach the city from the east and south by river bridges, while the fourth proposed radial, the Yanchep Highway, is planned as a freeway to serve the north-western suburbs.

Of the four radials, two are now built, being the Perth Causeway and the Narrows Bridge. Southward of the Narrows Bridge three miles of the new Kwinana Freeway have been completed.

It will be observed that the treatment incorporates a large fringe car park accommodating 2,300 vehicles which intercepts and stores a big proportion of the vehicles proceeding towards the city. The Narrows

Fig. 3. Lay-out of the bus and car park terminal on the North Bank.

Bridge, its approaches, and the fringe car park have been designed to meet immediate needs for traffic dispersal and storage on the fringe of the city, and for future integration with the proposed ring road system described. Thus in the broad sense the traffic engineering problem was to design the geometrics of the Kwinana Freeway, the Narrows Bridge, and the approach system in such a manner that they would meet immediate traffic needs in the first stage of their development, and could be integrated later, with adequate traffic capacity, into the proposed system of inner ring road, fringe car parks and new radial highways. In seeking a solution of this problem it was considered that future traffic flows over the whole central city area must be estimated and assigned to the different components of the system. These considerations called for traffic distribution diagrams completely in balance with the capacities of the street system, the proposed new ring and radial highways, and the total ultimate parking facilities.

Traffic counts have been established at a cordon around the central city area for some nine years and included in these surveys was an O-D Survey obtained by issuing postcards to motorists entering the city at the cordon points. The surveys have indicated that the dominant feature of Perth traffic is the heavy radial peak flows, which tax many facilities to possible

Fig. 4. Point Lewis Drive-Mounts Bay Road-Mill Street channelized and signalled intersection.

Fig. 5. View from mid-way up one spiral of a pedestrian overway, looking across to the other spiral. Dual carriageways, median strip, guard rails, fence, etc., are shown to advantage.

capacity twice a day. At morning peak 88 per cent of the vehicles moving towards the city centre have destinations within the cordon, and a large proportion of these will require parking space within the cordon for a large part of the day. Between peaks traffic is lighter, and can everywhere be accommodated in facilities designed for the peak demand. It was decided therefore to establish relationships between city bound morning peak traffic and parking demands; to relate the ascertained traffic flows and parking requirements to the existing working population and availability of floor space in the central business district, and to expand these figures to the ultimate demands which would be set up by the adoption of the zoning proposals for the city centre, in the Regional Plan, assuming an increase in the city work force of approximately 200 per cent.

The estimated increase in the city work force is based on the assessment that the Perth Metropolitan Area will in some 40 or 50 years accommodate a total population of about 1.25 million people. With the growth in population there must be development of new opportunities for employment, not only in the city centre but in new industrial and commercial areas. Thus the Regional Plan has provided for some dispersal of employment opportunities, and, in the traffic studies, groupings of future populations and the movements of workers to every employment centre have been balanced with regard to the locations of the residential areas and the work centres. It has thus been possible to suggest the ultimate numbers of workers who will converge on Perth at morning peak from each of the residential areas, and to establish for each of the major radials a traffic catchment area. In this manner it has been possible to assign flows to all the existing radials, major and minor, and to the proposed new radial highways, and to relate the total demand for city bound peak movement of workers to the traffic capacity of the city street system and of the existing and future car parks. This examination has suggested that the peak hour traffic movement of the future can be accepted at reasonable cost, and without undue disruption of the city's character, provided that only 34 per cent of the total workers proceeding to Perth at morning peak period use private transport.

In essence, because of the emphatic peak hour character of traffic in the C.B.D., the surveys have been directed toward isolating this aspect of the traffic problem and designing for a completely balanced system to meet future estimated peak hour flows to and from the C.B.D., having regard to the capacity of the city to accept the traffic in its street system and in the proposed ultimate parking provision. Important limiting factors have been the availability of space for parking, having regard for aesthetics on the river front, and the desirability or otherwise of making over large areas of the city for this purpose.

It may be added that the city work force at present is of the order of 66,000 persons of whom approximately 58,000 enter the cordon, other than on bicycle or on foot, between the hours of 7 a.m. and 9 a.m. Of these 58,000 people, approximately 52 per cent use private transport, the average number of persons per vehicle being 1.7. It is considered that this high usage of private vehicles cannot be sustained as the city grows, and that public transport will have to carry a greater proportion of the traffic if the city centre is to maintain its present character.

The basic related factors on which the ultimate peak hour flows were computed may be summarized:

(1) The location and future density of the residential districts generating traffic to the city centre, having regard to the effect of other future employment areas proposed in the Regional Plan.
(2) The recommended zoning of the Regional Plan in respect of the total working floor area proposed in the city centre.
(3) The capacities of the existing and proposed radial roads conveying traffic to and from the city centre.
(4) The capacities of the several sections of the proposed inner ring road system.
(5) The capacities of the inner street system within the proposed ring road, having regard to the capacities of key intersections.
(6) The capacities and locations of car parking areas, existing and proposed, both on the fringes served by the inner ring road and within the ring.
(7) The level at which public transport should be maintained.

From the consideration of these factors in association, it was possible to draw up a set of traffic flow diagrams for peak traffic in the future over the entire central city system, and thence proceed to the design of the various component facilities. In designing the Narrows Bridge and its approaches it was accepted that these facilities would ultimately be called upon to operate at possible capacity at peak periods, and that as traffic increased the bridge should operate at peaks on a reversed 4:2 lane basis to accommodate the unbalanced peak flows; that is that there should be four lanes of traffic inwards to the city at morning peak and four lanes outward at evening peak. At present the bridge operates three lanes in each direction at all times.

Against the background of this long-term planning, consideration had to be given to the design of the first stage development, which has now been built, particularly in respect of the design of the channelized intersections distributing traffic into the city. For these purposes data was taken from the O-D Survey, and traffic from south of the river was assigned to the existing Causeway structure and to the new Narrows Bridge in accordance with established mathematical methods of traffic assignment, based on considerations of distance and time on the altern-

ative routes. The flows thus assigned to the Narrows Bridge were again examined in relation to destinations declared to the O-D Survey, and their movement further assigned either to the new fringe car park or to the system of distributing streets which are served by the Narrows Bridge approaches. The capacities of the signalized channelized intersections distributing traffic to the inner street system were estimated after studies of saturation flow through existing signalized intersections and computed in accordance with methods developed in the Road Research Laboratory, Great Britain, based on optimum cycle times. All traffic light signals in Western Australia are traffic actuated.

The facilities provided in the first completed stage of construction are as shown diagrammatically in Fig. 2 and comprise:

(a) The Narrows Bridge with six traffic lanes and two footpaths. The vehicular carriageway is 70 ft. between kerbs and each footpath, which is fenced off from the carriageway, is 10 feet wide.
(b) South of the bridge three miles of new freeway, the Kwinana Freeway, with two lanes in each direction, restricted to motor vehicles and fenced off from pedestrian and extraneous vehicular movement. Except under emergency, stopping on the freeway carriageways is prohibited to all traffic. Provision is made to widen the freeway to six lanes.
(c) The approach system on the south bank connecting with the local residential street system.
(d) The approach system on the north bank connecting with the city street system and fringe car park.
(e) The large fringe car park accommodating 2,300 vehicles.

For aesthetic reasons it was considered that no on or off ramps should be incorporated in the Narrows Bridge structure. Consequently, the left-hand turn off the bridge in a westerly direction along Mounts Bay Road was accommodated by providing an off ramp well beyond the bridge abutments, and permitting this traffic to conflict at grade with traffic from Mounts Bay Road wishing to turn on to the bridge and travel southward. This latter traffic, as shown in Fig. 2, crosses the traffic leaving the bridge, passes under the bridge structure and enters the left-hand lanes for south moving traffic at the bridge. This at-grade conflict was acceptable because the traffic studies had shown that neither of these conflicting movements would reach high proportions, and the conflict has been efficiently resolved in a traffic rotary providing 98 ft. radius on the central island. The size of this rotary was limited by the steep bluff of King's Park which descends close to the river at this point and restricts the area in which the intersection could be constructed. In practice, however, the treatment has proved successful and in appearance is a more attractive feature in this pleasant river setting than ramp structures on the bridge would have been.

On the north bank, distribution to the city street system is through three signalized intersections at Spring Street, Mill Street and William Street, as shown. A feature of the William Street intersection is the bus terminal which has been incorporated in the large channelizing island. Vehicles entering and leaving this terminal loop are controlled by the intersection traffic lights. The feature was not desired on traffic engineering considerations since it shortened the length of the weaving section immediately south of the intersection. However there was no other

Fig. 6. Southern approaches to the Narrows Bridge from King's Park, showing Kwinana Freeway in the background along the foreshore to the right.

available land, having regard to the requirements of land for the car park on the west side and the recreational open space on the east side of William Street, which could not be interfered with. Apart from the enforced shortening of the weaving section brought about by the bus terminal, the layout has been acceptable and at peak periods approximately 40 buses per hour enter and depart from the terminal. The layout is illustrated by Fig. 3.

The car park, which is essentially a central island in a large traffic rotary, has worked very well and no difficulty is experienced in entering or leaving it at peak periods.

On both north and south banks small parking areas have been planned for casual sightseeing, as shown in Fig. 2. To date these have only been constructed on the north bank. The complex of facilities comprising the car park and the three intersections at Spring Street, Mill Street and William Street is at present accepting morning peak flows inwards to the city of approximately 5,000 v.p.h. without any congestion. The car park absorbs an important proportion of this flow.

Other features of interest include five prestressed concrete pedestrian overways approached by spiral ramps at grades of 10 per cent.

Throughout the freeway and bridge approach system, fully reflectorized direction and advanced direction signs of white lettering on a green background have been provided. At entry and exit points on the freeway and the bridge approach system, differential pavement colours have been used to segregate acceleration, deceleration, and turning lanes from the through carriageway lanes. Pavement edge markings have been used throughout the freeway.

ACKNOWLEDGMENT

Acknowledgement is made to the Commissioner of Main Roads, Western Australia, Mr. J. Digby Leach, B.E., M.I.E. (AUST.), M.INST.T., *under whose direction the works described were planned and constructed and who has kindly given permission for this article to be prepared.*

ASSISTANCE for ROADS in UNDER-DEVELOPED COUNTRIES

by **Christopher Brunner,** *Chairman, International Road Federation (London)*

In this article the author discusses ways in which technical aid can be given for roads and road transport in under-developed countries, and in particular, what the new Department of Technical Co-operation could contribute.

FOR centuries Britain has invested capital and given technical assistance, not only to her dependent territories, but in circumstances as different in time and place as teaching Peter the Great's Russia how to build ships to the introduction of railways in Latin America.

Yet the extent of the problem of the under-developed countries, and the challenge which they present, has only been fully understood comparatively recently by the more wealthy industrialized nations. The problem first received major recognition with the formation of the World Bank in 1945. Paul G. Hoffman, in his excellent study, 'One Hundred Countries and One and One Quarter Billion People', estimated that, including China, over three-quarters of the world's population are living in conditions of poverty, illiteracy and ill-health. Religious and philanthropic bodies had for years tried to grapple with poverty, both in their own lands and overseas, but any attempt to deal with the situation on anything like the scale necessary, only became possible with the growing world realization that foreign aid was an investment, not only good in itself, but beneficial to all countries: for, as Hoffman points out, 'aid is trade' and 'today no single country, rich or poor, can achieve maximum economic growth except in an expanding world economy'.

In the under-developed countries basic public services are poor, there are insufficient schools, universities, hospitals or cultural centres, and communications are inadequate or non-existent. Usually the economy is geared to a predominant extent either to subsistence agriculture, the production of a raw material or some staple product. One of the basic reasons for under-development is the under-utilization of physical and human resources; such countries lack knowledge not only about their own potential resources but have inadequate data and statistics with which to measure the performance of their economy and what is happening.

The great need of the under-developed countries is, therefore, for detailed surveys to establish the full facts of their natural resources so as to be able to assess those fields in which the economy can be diversified by the establishment of local industries. The governments concerned must provide the basic social capital to provide the infra-structure of adequate public facilities and services and the communications system without which 'self-perpetuating economic advance' is not possible. In addition, technical research is needed to show how local materials can best be utilized.

The White Paper which examined the establishment of the new Department, made no 'attempt to survey the future tasks and scope of United Kingdom technical assistance'.

In the remainder of this article some instances are given of the technical aid which is at present granted to overseas territories for road and road transport development, and suggestions made of some of the ways in which the Department of Technical Co-operation could give greater assistance in the future.

Nature of Aid

In seeking to assist the under-developed countries to stimulate and diversify their economies and to raise their standards of living, there are two basic and related problems. The first is the provision of adequate financial resources, and the second is aid to enable the necessary know-how of modern processes and techniques to be learnt by nationals of the country receiving assistance. The provision of capital is by itself not enough; the under-developed countries will never come to stand on their own feet unless they can train the engineers, managers and skilled operatives necessary to man power stations, factories, public services and installations.

Technical Assistance

An important development in Britain is the establishment of a Department of Technical Co-operation to co-ordinate technical aid to overseas countries, which was previously a function divided between the Foreign Office, the Commonwealth Relations Office and the Colonial Office, depending on the status of the country receiving assistance. The new Department has no responsibility for finding capital for the overseas countries, but is concerned with:

> Training in the United Kingdom and overseas, the provision of experts, administrators and other professional men and women; the provision of advisory technical and consultant services and expert missions, and the supply of equipment for training, demonstration, pilot schemes or surveys.

Road or transport planning to establish the communication network which is required can only be carried out properly by assessing data gained from broad economic surveys. Several such surveys have been carried out by the World Bank, the United Nations and other organizations, but much more work is required, not only to establish the requirements of particular nations, but also to give a better understanding of the full significance of international links. The International Road Federation is actively pursuing this latter objective by instigating surveys. It has already made substantial contributions, among them, good progress on the southern sectors of the Cape to Cairo Highway, certain sections of the Trans-Asian Highway, and the Pan-American Highway.

Another aspect of road planning is the need to justify money spent on road construction. In Britain and other highly industrialized countries the return on capital invested in roads is mainly determined by calculating the money saved through shorter journey

Fig. 1. One-way road leading to the Zomba Plateau. Upward and downward traffic share each hour equally.

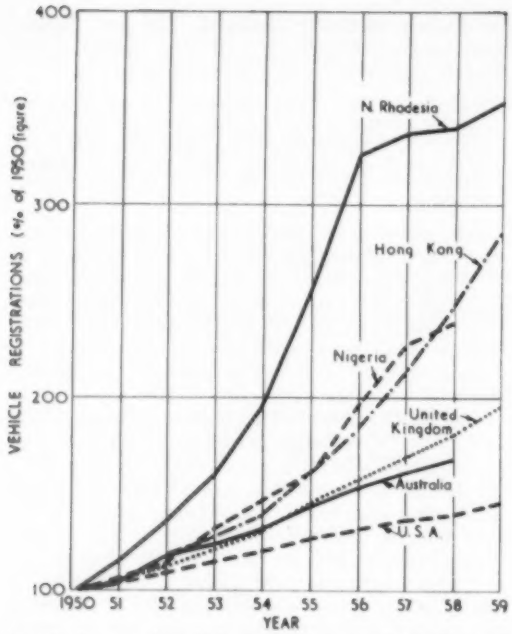


Fig. 2. Increase in vehicle registrations on 1950 *figure as* 100 *per cent (Road Research Laboratory, D.S.I.R.)*

times, lower vehicle running costs and a reduction in accidents, compared with the capital costs and maintenance charges of particular highway construction or improvement projects. In fact, the economic benefits of roads are much greater than their more obvious direct benefits show, and this is often most easily observed in places where hitherto there has been scarcely any economic activity. As Dr. R. S. Millard, Head of the Tropical Section and Colonial Adviser on Roads, wrote in his paper 'Road Development in the Overseas Territories',

> 'Overseas the benefits from new road construction are almost entirely in the form of new development, from the traffic which the new road will generate. Such development is frequently difficult to predict except in general terms . . . this is undoubtedly one of the reasons for difficulties in finding funds for new road work'.

Dr. Millard goes on to point out that much valuable assistance could be given to the overseas countries if more comprehensive methods of assessing the benefits which accrue from new road construction could be developed.

On the planning side, one of the subjects studied by the Tropical Section is the method of developing rural roads and the effects of road-building on agricultural progress. The standard to which rural roads are to be constructed must be determined so that the roads are neither too costly nor so crude as to be useless for their purpose; also they must not involve expensive maintenance. The network and type of road required will vary with the crop to be marketed—'hard' fruits, for example coconuts, can be humped for a certain distance and can undergo transport along rough roads without suffering damage, whereas 'soft' fruit, like bananas, will bruise and deteriorate unless carefully handled and transported.

Important pioneering economic studies have been undertaken by the Tropical Section. In the West Nile District of Uganda it was found that, while feeder roads brought population into the area, the acreage of cotton grown per head of population, nevertheless, increased by approximately five times, while in adjacent areas, where no new roads were built, the acreage per head decreased. Similar studies are now in progress in North Borneo, where the effects of road-building on other forms of agricultural development—rubber, rice, coconuts and timber—are being examined. Another important aspect of research of the Tropical Section is into vehicle operating costs on various types of road surface, and studies are being made in East and Central Africa in collaboration with transport firms operating vehicles on earth roads, gravelled roads and roads with bituminous surfaces.

The countries overseas are also beginning to be faced with difficult urban problems, although in many cases, because it is possible to spill into adjacent land, the gravity of the situation may not yet be very apparent. Towns and cities are growing extremely fast, with the increase in public service and commercial offices, the movement of people away from the land, and the growth of industry. In the ten years up to 1960, for example, the population of

Basic Road Statistics for 1958

	Population ('000)	*Registered vehicles*	*Area (sq. miles)*	*Road mileage*	*Road mile/ sq. mile*	*Vehicles/ mile of road*	*Vehicles/ '000 population*
Northern Rhodesia	2,300	42,330	288,130	22,407	0.08	1.9	18
Nigeria	34,407	62,037	373,250	37,000*	0.10	1.7	1.8
Hong Kong	2,806	32,778	391	479	1.23	68	11.7
United Kingdom	51,290	8,092,000	95,619	191,146	2.00	42	158
Australia	9,846	2,411,000	3,000,245	520,000*	0.17	4.6	245
U.S.A.	171,163	68,328,000	3,657,339	3,455,000*	0.94	20	399

(*Approx.)

Fig. 3 *Growth of Road Traffic.*

Lagos increased 40 per cent, that of Dar-es-Salaam nearly doubled, and over a slightly longer period Salisbury, Southern Rhodesia, grew from 69,000 in 1946 to 260,000 in 1960.

This rapid expansion should provide an opportunity to plan cities so that the best use can be made of road transport, and the Road Research Laboratory has already undertaken traffic investigations in Lagos, Hong Kong, and Kingston (Jamaica).

The second aspect of technical assistance and equally important—in the long run perhaps even more important—as the provision of expert advice, covers the training of overseas engineers. Such training can be undertaken in a variety of ways. At the beginning of the 1960-61 academic year, there were some 2,500 students from overseas studying engineering at British universities, while a further 3,000 were receiving engineering training at technical colleges. In addition, many young engineers, having completed their academic studies, obtain up to two years practical training with local authorities, consultants or contractors in this country; there are about 250 overseas engineers undergoing training at present.

The body of knowledge at the Tropical Section on road building, traffic and planning is made available through publications and by frequent travelling by its staff who advise on local problems and undertake research with people on the spot. Another important way in which the results of research are disseminated is through particular training courses. Each year some 50 engineers from overseas attend the Road Research Laboratory's courses on road materials and methods of construction, and a growing number are attending courses on traffic and road safety. In addition, the Laboratory takes in each year a number of engineers from overseas for training, for at least six months, in the testing of road materials. During the past three years engineers have come for such training from many countries including Borneo, Malaya, Kenya and Nigeria.

Department of Technical Co-operation

I have given some examples of the technical assistance which is currently being extended by Britain in the field of road and road transport development, and also indicated how much is still to be done to ensure that overseas countries secure, for minimum cost, the roads fundamental to their economic progress and to international unity. In urban areas it is most important to avoid the errors of older countries, whose towns and cities originated in a pre-motor transport era. The formation of the new Department of Technical Co-operation presents an opportunity to examine the ways in which assistance could be extended and broadened. Already the courses covering the work of organizations, like the Tropical Section, have proved of value in providing the overseas territories with some men trained in up-to-date road techniques. At present the cost of young engineers, policemen and administrators attending these courses is met by the overseas government concerned. Most of the students take the courses as an extension to their leave in this country and thus, as the number of expatriates declines, attendance at these courses is likely to drop. A valuable contribution which could be made by the Department of Technical Co-operation would be in helping to finance students, particularly those from the poorer countries.

Many of the smaller territories do not have the resources, nor the requirement to employ full-time the experts necessary to study and evolve comprehensive and well-planned road development. One of the functions of the new Department should be the creation of pools of experts, who would be available to visit and advise the overseas territories as required. Because of the lack of experts in road construction and development, the Tropical Section is continually under pressure to deflect its efforts away from its main research function, towards the practical application of research. To meet this need the Road Research Laboratory has suggested that a pool of materials engineers should be formed, who would be attached to the Laboratory. This is a sound idea which should be extended to cover traffic engineering and road planning. Little value can be derived from road research unless each country either has its own fully trained staff, or can be certain of obtaining the advice of experts as particular problems arise.

In Britain, the essential role of traffic engineering in ensuring the sound planning of road development and the most efficient use of existing roads has only lately been recognized. Four one-year bursaries are already offered—two by the London Office of the International Road Federation and one each by the Shell International Petroleum Company and by the Dunlop Rubber Company—to overseas students to take post-graduate courses in highway and traffic engineering in this country; the Department of Technical Co-operation would be investing wisely for the future if it were to offer further opportunities for engineers from overseas to study highway and traffic engineering at Birmingham, or any of the other universities where post-graduate courses are now provided, or come to be provided.

Conclusion

The establishment of a Department of Technical Co-operation must not be regarded merely as an organizational change—a simple tidying up of administration—but presents an exciting opportunity to review Britain's scope for assisting the less highly developed countries. There is a wealth of knowledge in Britain, which is steadily increasing, of the problems which face overseas road engineers, but full advantage can only be taken of this knowledge if the overseas territories can send their own staffs for training, or if sufficient experts are available to visit the smaller territories when the need arises. In the field of traffic engineering we, in this country, have learnt the hard way, and there is an urgent need, not only to increase the number of qualified men to work in this country, but to offer additional assistance overseas.

The Department of Technical Co-operation will have to determine the priorities between education, medicine, science, engineering and the many other fields in which the under-developed countries lack know-how and experience. No country can make satisfactory economic progress unless it has an adequate system of communications, and the success of many activities will often depend on there being roads in the first place. The new Department can help ensure that sufficient understanding and priority is given to road planning and construction, and to traffic engineering techniques in the under-developed countries.

TRAFFIC ASPECTS of URBAN INTERSECTIONS

by Baurat Dipl.-Ing. **HANSKARL SCHREINER**

The author of this article gives his views on traffic and building aspects of urban intersection design arising from his experience in planning and executing the general traffic plan of Essen, Western Germany, and the planning and construction of the Ruhr Urban Motorway.

Fig. 1. Signal-regulated T-junction along a main traffic artery: markings, grass patches, and white attachment of the pedestrian areas to the guide islands enhance its optical effect (Air photo Dieter Storp).

European Report

THE traffic engineer of a large German city is today principally confronted by two problems:

(1) He should be far sighted in planning an efficient highway system and, in the course of the reconstruction or the conversion of the historic type of city into one consistent with modern traffic requirements, make provision for conditions that may be needed by traffic growths.

(2) He must meet the steadily increasing pressure of traffic by suitable short-term measures.

As the German traffic engineer is not a traffic specialist in the narrow sense of the word, but a civil engineer who has included road traffic technology in his studies, as being one of the pre-requisites for modern road-building, he finds that the technical planning of traffic is closely associated both with the civil engineering considerations that are necessary for realization, and with their financial effects.[1]

In city road-building, with its many compulsive conditions that often run counter to the demands of traffic, he is seldom in a position to put into effect an ideal solution from the viewpoint of traffic engineering. In order, nevertheless, to develop spatially, technically and aesthetically, a satisfactory traffic system, he must make rational use of space and time, employ traffic engineering methods, and exhaust civil engineering possibilities.[2, 3, 4, 5] The planning engineer must judge in each individual case to what extent compromises between constructional planning and traffic engineering demands are permissible, or in which cases larger sums have to be expended to arrive at what is needed from a traffic point of view.[6]

My remarks are confined to a few problems taken from the routine traffic planning work, which indeed is often somewhat eclipsed by the major planning tasks, yet which is of considerable importance if a traffic system is to meet the demands made on it as regards safety, efficiency and economy.

The increasing pressure of traffic makes itself noticeable above all at the intersections of the town road system. The flow of traffic comes to a halt and in peak hours traffic is almost entirely at a standstill. Accidents are on the increase. Something has to be done so that until long-term, large scale planning takes effect, efficiency can be increased and the standard of traffic safety raised. Traffic counts and investigations into the causes of accidents form the basis of the necessary traffic engineering measures.[7, 8] In most cases, measures for regulating traffic do not accomplish this aim. Constructional transformations are needed. The planning and dimensioning of the intersection and its components depends on the estimated load furnished by traffic analysis.

On urban freeways the intersections are in principle built on several planes. Expressways within the town are given, as far as possible, intersections on different levels. The majority of the urban intersections must, however, for reasons that call for no explanation, be developed on one plane and as far as necessary be regulated by signals. One of the basic demands made on an intersection is that it must be understandable for drivers: it must be designed on simple, clear and comprehensible lines. The basic form of a junction should also be maintained so that drivers and pedestrians become accustomed to the corresponding form of junction for certain situations (Figs. 1 and 2). This principle cannot be overestimated for conflict-free and safe traffic conditions, for those taking part in traffic find that their powers of comprehension are severely overtaxed owing to the large number of influences that are brought to bear on them.

Furthermore, in planning a road system allowance must be made for technical driving conditions. The road user should be carried along with imperceptible compulsion so that he feels the prescribed movement to be correct and obvious.[9] Curves must be formed

Fig. 2. Signal-regulated intersection of a traffic road with a major road (the vehicle paths show good alignment with the design of the junction). (Air photo Dieter Storp).

(Photo: Claus Christoffers, Essen).

Fig. 3. Preliminary marking of a guide island with white paint.

in such a way that they correspond to the steering operations and adapt themselves to the line of the traffic lanes. Particularly on narrow curves, special attention must be given to the kerb line. Observations of wheelmarks in snow readily show when the necessary corrections should be made. Years ago, the writer carried out driving tests with different kinds of vehicles in order to determine the line of the wheels on narrow curves.[10] On the basis of the track diagrams prepared, curves were obtained that correspond with sufficient accuracy to the movement and permit of rapid and simple delineation. Practical examples carried out, as well as research conducted by Prof. Dr.-Ing. Hunger on behalf of the Forschungsgesellschaft für das Strassenwesen (Roads Research Association), have confirmed or clarified the results then found. Moreover, clothoids should not be dispensed with for urban road planning on account of driving or aesthetic reasons.

Divisional and channelizing islands should receive the special attention and care of the engineer. Errors in design and construction can so change the effect of islands as guiding and safeguarding factors that they become a danger point and an obstacle. In difficult situations the responsible engineer should make sure of the correct position and design, on the spot, prior to final erection. Marking out in colour, or building up an island from bricks, permits of corrections before the kerb stones are placed in position

(Photo: Claus Christoffers. Essen).

Fig. 4. Guide island corresponding to the preliminary marking of Fig. 3 after installation.

(Figs. 3 and 4). The marking of carriageways, when properly carried out, brings order to the flow of traffic, enhances the safety of those taking part in traffic and, through the better utilization of the surfaces of the roadway, increases the efficiency of a traffic installation.[12,13] Even in a narrow space, under unfavourable conditions of visibility and curvature, by means of well designed marking of the carriageway, which allows for the widening of the track on curves, a multiple-lane flow of traffic can be ensured. (Fig. 5).

The white marginal strip, which is already a matter of course as the optical boundary of the road for highway construction in rural areas, is now beginning to find its way into urban road building. Owing to the high kerbs between the carriageway and pavements in towns, especially in industrial areas, it is subjected to considerable soiling, which at times impairs its optical effect. An additional row of white panels placed on the pavement immediately behind the kerb, greatly improves visibility (Fig. 6).

Turning lanes for vehicles leaving the road on the left are provided in Germany, where traffic drives on the right, and where efficiency or the regulation of signals calls for it. Right-turning vehicles, on the other hand, are not generally allotted a special lane, as these travel, as a rule, in the same signal phase as through traffic. With the increasing co-ordination of signal-controlled junctions to form green waves, this latter procedure has, however, been found disadvantageous. Turning takes place at very much lower speed than that used in the course of a green wave. Even a single vehicle turning to the right is an obstacle in heavy traffic to the flow of through vehicles and this contributes to the occurrence of the undesirable concertina effect. Efforts are made, therefore, as far as possible, on a road with co-ordinated signal-controlled crossings to provide right-turn lanes at intersections.

Obstacles to the flow of traffic are often caused by bus stops at the side of the road, and passengers alighting and boarding the vehicle block the nearside lane. The result is that many drivers do not use the nearside lane or, if they do so, change lanes more often. When traffic is dense, this makes for less safety and the efficiency of the road is impaired. Whenever possible at bus stops, therefore, bays are provided into which the bus drives and the lanes are then released for the flow of traffic during the stopping time. The appropriate form of bus stop bay was determined by the writer in conjunction with the Essener Verkehrs A. G. by means of practical tests.[10] Allowance was made for the rate of traffic flow, for the influence of the braking and starting procedure on passengers and for the method of driving. The results of these practical tests form the basis of the relevant directives of the Forschungsgesellschaft für das Strassenwesen.[1,14]

In traffic engineering planning sufficient attention is often not paid to the vegetation of the road area. The traffic engineer has opportunity to satisfy the city dweller's need for green spaces while combining it usefully with the needs of traffic engineering. Correctly planned they can enable many guide devices and protective railings to be saved. Properly laid out they give life to the road area, support the optical effect of a traffic installation, prevent uncontrolled crossing of the carriageway by pedestrians, and guide the latter to safe crossing places.

An important factor of traffic engineering planning is also street lighting. It can no longer be planned, as was formerly customary to a large extent, without regard to traffic and highway engineering. On urban roads, where the traffic load is very high even in the evening, good street lighting is a prerequisite for adequate capacity and for road safety. Collaboration between lighting and traffic engineers is particularly called for. In Germany, according to the importance of traffic on a road, certain mean horizontal light intensities on the surface of the roadway and corresponding uniformity are required. Dark zones on the carriageway, which make it difficult or even quite impossible for drivers to detect objects or pedestrians, reduce the safety of traffic, just as dazzling light does. The construction of road surfaces and lighting technology can supplement one another, on the one hand in making the surfaces of roads a good deal brighter, and, on the other, in developing dazzle-free lights with economical light yield. Quite often in laying out street lighting allowance is not made for reflection which is directed towards the driver. The result of this is that a carriageway which appears uniformly lit when dry is resolved optically when wet into an alternating sequence of light reflecting streaks and dark zones in between. By the correct arrangement of lights it is possible to produce in wet weather a coherent reflection strip, as seen by the driver, against which any obstacle in the roadway, whether a vehicle or a pedestrian, becomes visible as a silhouette. As the sources of light needed for the proper lighting of a highway are as a rule within the driver's field of vision, they should support the traffic engineering function of optical guidance at night.

Junctions should be discernible at an early stage even in darkness and their layout should be perfectly visible. The former can be arrived at by the use of a different type of lighting or by a higher level of illumination compared with the streets converging there. The second condition can only be satisfied at junctions covering a large area by adequate lighting. With individual lanterns over the various carriageways of the junction it is often not possible to obtain any traffic guidance. In such a case the large number of individual lights appears to the motorist, according to the angle from which he sees it, as an unco-ordinated accumulation of dots of light displaying no system. Therefore, in the case of junctions covering a large area, illumination by a few wide-area lanterns with suitable mounting height is probably best.

In conclusion, it must be stated once again that a road traffic installation can only properly serve its purpose if it is correctly planned and designed from an engineering point of view so as to be faultless in every detail. It is, therefore, the task of the traffic engineer to determine all influences according to the current state of technology with the available methods of science and practice, and to allow for their effects on the design by taking advantage of technical possibilities, so that an optimum solution can be found.

REFERENCES

[1]J. Schlums, 'Die Ausbildung von Strassenbau- und Verkehrsingenieuren', Beilage zu 'Brücke und Strasse' 1956, Heft 4.

[2]J. W. Korte, 'Grundlagen der Strassenverkehrsplanung in Stadt und Land', Bauverlag GmbH, Wiesbaden und Berlin.

[3]Richtlinien für die Anlage von Stadtstrassen (RASt) Teil I, Forschungsgesellschaft für das Strassenwesen e.V. Koln.

[4]Richtlinien für die Anlage von Stadtstrassen (RASt-O) Anlagen des vffentlichen Personennahverkehrs, Forschungsgesellschaft für das Strassenwesen e.V., Kvln.

[5]C. Christoffers, 'Anlagen des vffentlichen Personennahverkehrs in Stadtstrassen, Ein Kommentar zu den Richtlinien der F.G.f.d.Str. RASt-O, Schriftenreihe für Verkehr und Technik 1961, Erich Schmidt Verlag, Bielefeld.

[6]J. Schlums, 'Verkehrsleistung und Baukosten als Massstäbe für die Bewertung von Strassenplanungen', Strasse und Autobahn 1960, Heft 2.

[7]Richtlinien für Stadtstrassen-Verkehrszählungen vom 1.11.1952, Forschungsgesellschaft für das Strassenwesen e.V., Köln.

[8]Merkblatt für die Auswertung von Strassenverkehrsunfällen in strassenbau- und verkehrstechnischer Hinsicht, Forschungsgesellschaft für das Strassenwesen e.V., Köln.

[9]C. Christoffers u. K. Zinken, 'über die verkehrstechnische Gestaltung von Strasseneinmündungen', Strasse und Autobahn 1957, Heft 9.

[10]E. Oehm u. HK. Schreiner, 'Fahrspurenkunde als Grundlage für die Ermittlung von Konstruktionselementen im Strassenbau', Strasse und Autobahn 1956, Heft 11.

[11]F. Hunger, 'Fahrbahnführung für Eck- und Wendefahrten' Forschungsauftrag der Forschungsgesellschaft für das Strassenwesen e.V., Köln, 1958.

[12]Merkblatt für die Anordnung von Fahrbahnmarkierungen auf Stadtstrassen, Ausgabe 1956, Forschungsgesellschaft für das Strassenwesen e.V., Köln.

[13]Hinweise für die Anordnung und Ausführung von Fahrbahnmarkierungen auf Bundesstrassen (HMB), Fassung 1954, BMV.

[14]Merkblatt für die Platzwahl und Ausbildung von Haltestellen für Omnibuslinien an öffentlichen Strassen, 1956 Forschungsgesellschaft für das Strassenwesen e.V., Köln.

(Photo: Claus Christoffers. Essen).

Fig. 5. Marking of carriageway at the intersection of a federal highway through a town and a principal street of the town. Visibility is greatly impeded by the location of the intersection on a rise. The existing buildings (on the right of the photo) prevented a better layout, but by means of corresponding carriageway marking a two-lane flow of traffic in each direction is achieved.

(Photo: Claus Christoffers, Essen).

Fig. 6. Example of the enhancing of the optical effect of the white marginal strip by white panels behind the high kerb.

DEVELOPMENTS I

▲ *Above and Right. The Hammersmith Flyover nears completion. The superstructure, consisting of prestressed concrete cantilever arms to bear the carriageways, is supported by slender columns arranged to give 16 spans of varying lengths, from 74 ft. to 140 ft. The Flyover will connect the western end of Cromwell Rd. Extension to the Great West Road, and should be opened this Autumn.*

▶

Below. On the Maidenhead By-pass, Kimbers Lane footbridge provides an easy crossing for cyclists and pedestrians with prams. Access to the bridge is by means of ramps arranged in three stages.

▼

[Photo : John Laing & Sons Ltd.

TS ILLUSTRATED

[Photos: Roads Campaign Council

Above and Left. Two miles of the city's new motorway network opened and 2.4 miles under construction, West Berlin expects to complete 10 miles by 1964. With a designed speed of 50 m.p.h., each traffic lane is 11.3 ft. wide and there is a central reservation of 6.5 ft. On the left is a view of an entrance to the six lane tunnel below the Kurfuerstendamm, in the city centre.

Below. The new Maidenhead By-pass is opened. Eventually to form a link in the London-South Wales Motorway, this By-pass has dual carriageways of 24 ft., a central reservation of 13 ft. and is flanked by hard shoulders.

[Photo : John Laing & Sons Ltd.

Central Business District

LAND USE and TRAFFIC GENERATION

by **H. M. Edwards**
Associate Professor of Civil Engineering, Queen's University, Kingston, Ontario

and

B. C. S. Harper
Traffic Engineer, Clarke Gazzard and Yeomans Edgecliffe, New South Wales.
Former Graduate Research Assistant, Queen's University, Kingston, Ontario

THE concept of the application of land use information to predict trip generation has received considerable attention by urban transport planners during the past few years. Much information has been collected and collated in an attempt to develop theories which would reflect daily trip movements in the urban area. The primary purpose of the majority of these investigations was to develop relationships providing a sound basis for forecasting trip movements for the urban area as it develops and expands.

Such aims are of great interest to the planner of roads and work to date has shown much promise. However, in searching the literature, the authors of this article discovered two principle areas where there seemed to be deficiencies in previous investigations:

(1) The investigations have largely omitted refined evaluations of the trip generation effect of central business district (CBD) land use.

(2) Most investigations have been confined to a single urban area not attempted to determine whether similarities in trip movements occur in cities which exhibit similar characteristics of size and economic activity.

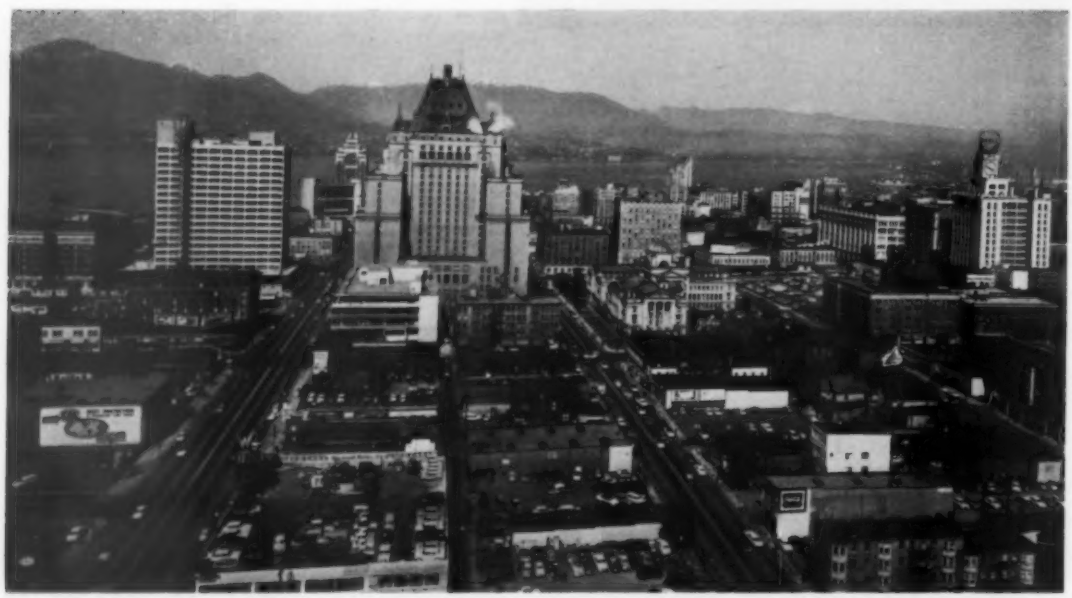


Fig. 1. Vancouver: central business district.

Since it is known that in any urban area the CBD generates a relatively large number of person trips, and there also seems to be good reason to believe that the CBD will continue to be important, it was decided to attempt to determine whether any relationship existed between CBD floor space and trip movement to the CBD. If such a relationship could be developed, the investigation would be extended to examine several cities to determine whether the relationship developed for individual cities was similar for the groups of cities examined.

The investigation was undertaken in the hope that improvements in existing forecasting methods, which have largely been based on historical trends, would result. It was considered that an analysis should be made of all person trips rather than simply of motor vehicle trips since the ultimate transport plan must provide facilities for all movements. If this is correct, the forecaster could base his predictions on land use data, and the designer could provide facilities to satisfy future volumes in accordance with whatever mode of transport was expected. In this way, a certain flexibility in the planning and design processes would be achieved.

Fig. 2. Vancouver: looking east along Georgia Street in the new office building area.

Source of the Data

In this study, which undertook to examine the relationship between CBD land use and person trip destinations in that area, it was decided that land use should be expressed in terms of floor area in use. It might appear that any attempt to relate floor area to person trips would be a formidable undertaking, since a study of specific trip destinations, trip purposes, and mode of travel would require a great deal of detailed information. However, it was believed that much data was already available in the reports of home-interview origin-destination (O-D) traffic surveys and CBD floor area studies made in recent years in North America.

The floor area studies provided information on the amount of floor space in use in the O-D survey zones, thus it was possible to determine the amount of floor area in each zone in accordance with a predetermined classification of floor area use. The O-D study provided the total person trip destinations in each survey zone during an average 24-hour period. By combining these data it was possible to perform a regression analysis relating person trips to floor space. The coefficients in the resulting regression equation thus provided estimates of the trip attraction effect of the floor space types selected for analysis.

Contrary to expectation it was found that only six cities had data in the form required: Philadelphia, Detroit, Baltimore, Seattle, and Tacoma in the United States and Vancouver in Canada. Dallas, Texas was added after the city planners there supplied maps and building height and use information which could be converted into floor areas.

Although these studies were not performed at the same time, in the cases of Detroit, Philadelphia and Vancouver the time differential was quite small and probably not significant. For the other cities the results must be viewed quite critically because of the time differential between surveys (see Table 1).

In order to alleviate fears concerning the effect of time on CBD change, a study was made of an investigation performed by Horwood and Boyce[1] which provided an evaluation of the office space changes in the central areas of Baltimore and Seattle, 1946-1956. This indicated a degree of stabilization there during the decade investigated. Additional information was obtained by examining two O-D studies of Washington[2] made in 1948 and 1955, which showed that the number of people journeying to the CBD each year was approximately the same. These studies do not provide complete proof that the time differential between surveys is not important. However, the indications of stability in the CBD were reassuring and further analysis of the data seemed warranted.

When considering the raw data supplied concerning floor space it became evident that considerable variation in the classification of floor space was used by the various planning agencies. Since the investigation was, in essence, an attempt to formulate a new approach to traffic prediction, it was decided to

TABLE I

Cities, Population and dates of Field Surveys covered in the Analysis

Metropolitan Area	*State or Province*	1950 *Population*	*O-D Field Study Date*	*Floor Space Survey Date*
Philadelphia	Pennsylvania	3,671,048	1947	1948
Detroit	Michigan	3,016,197	1953	1954
Baltimore	Maryland	1,337,373	1946	1957
Seattle	Washington	732,992	1946	1956
Vancouver	British Columbia	600,000	1955*	1954
Tacoma	Washington	275,876	1948	1958
Dallas	Texas	614,799	1951	—

*Vancouver's travel information was developed from a survey of vehicle owners and of public transport users and, as a result, may not be as comprehensive as that provided by the home interview survey.

Vancouver was included primarily to add a Canadian city to the sample

simplify this initial study by grouping floor space data in broad categories. There was little doubt that complex relationships could be developed if fine differences in floor space use were incorporated. Nevertheless, it seemed more prudent to work with a broader classification system and, if this approach showed merit, subsequent studies of a more refined nature might be indicated.

Three broad floor space categories—retail, service-office and manufacturing-warehousing—were selected on the premise that each had fairly distinct characteristics and, in general, gave character to different parts of the city centre. There was also reason to believe that each of these three floor space groups would produce different rates of trip attraction. At the same time, it was recognized that each floor space group would encompass a variety of types and very likely have a different rate of attraction. This could be a serious weakness to the analysis, but it was hoped that the variations within any groups would not be large. Moreover, since the success of the prediction technique is dependent on land use forecasting, it should be apparent that extreme refinements in floor space use cannot be justified. Table II shows the floor space classifications listed by the various planning authorities grouped into three categories.

Since an attempt was to be made to relate trip attraction to three types of floor areas in the CBD, it was decided that a multiple regression analysis would be appropriate. However, it must be recognized that, in order to use this analysis technique, a theoretical or intuitive estimate of the form of relationship must be made. Had only two types of floor space been selected the observed data could have been used to construct a three dimensional model which would have provided a visual estimate of the form of the underlying mathematical law. The use of three floor space types precluded the model possibility. It was felt also that the deletion of one of the floor space types, in the interest of simplicity, was not warranted and this, along with further reasoning concerning conditions in the core of the CBD, led to the selection of a linear form of mathematical expression to explain the trip-floor area relationship. The analysis, therefore, consisted of an attempt to see how well the observed data fitted an equation of the form:

$$Y = b_1X_1 + b_2X_2 + b_3X_3 + k \quad \ldots\ldots (1)$$

where

- Y = number of person destinations in a zone in the CBD in an average 24-hour period from within the metropolitan area.
- X_1 = area of retail floor space in use in the zone expressed in thousands of square feet.
- X_2 = area of service-office floor space in use in the zone expressed in thousands of square feet.
- X_3 = area of manufacturing-warehousing floor space in use in the zone expressed in thousands of square feet.
- b_1 = coefficient of retail floor space generation when considered in conjunction with service-office and manufacturing-warehousing space.
- b_2 = coefficent of service-office floor space generation when considered in conjunction with retail and manufacturing-warehousing space.
- b_3 = coefficient of manufacturing-warehousing floor space generation when considered in conjunction with retail and service-office space.

TABLE II

Floor Space Classification

	Retail	*Service-Office*	*Manufacturing-Warehousing*
Philadelphia	Retail	Wholesale without stocks	Manufacturing—Wholesale with stocks
		Business Service	
		Consumer Service	Undetermined
		Hotels	
Detroit	Retail	Office Buildings	Warehouses
	Business	Parking Lots	Light Industry
	Open Business	Parking Garages	Heavy Industry
		Institutions	
		Utilities	
		Hotels	
		Terminals	
		Open Storage	
Baltimore	Retail	Business Service	Manufacturing—Wholesale with stocks unknown
		Consumer Service	
		Wholesale without stocks	
Seattle	Retail	Hotels and Recreation	Commercial
		Eating Places	Industrial
		Automotive Uses	Public, Semi-public
		Banks and Miscellaneous	
		Business Offices	
		Public Offices	
		Institutional and Organizational	
Vancouver	Retail	Office	Industry and Warehousing
		Public	
		Other	
Tacoma	Core Retail	Offices and Services	Warehousing—Wholesaling
	Intensive Retail	Consumer Service	Manufacturing—Industrial
	Extensive Retail	Amusement and Recreation	
		Hotel	
		Parking	
		Public	
		Quasi-public	
Dallas	Classified from map. Parking space omitted		

NOTE: Vacant and Residential floor space was excluded from the analysis.

In selecting a linear law of this type it is implied that each additional square foot of floor space in use, within each type in a zone, will cause an identical increase in the number of trips attracted. Certainly there are sections of a CBD area where such a law would not apply. For example, where slow growth is taking place in a certain direction, a zone on the fringe may be somewhat lacking in attraction. With additional development, such a zone may be able to supply a greater diversity of goods and services and become a more popular area. Such development would possibly best be described by a curvilinear relationship for the retail variable, since the effect of additional floor area would tend to be cumulative.

Manufacturing-warehousing and service-office floor area are unlikely to be influenced greatly by a cumulative effect of this kind and, in all probability, would always have a power index of approximately one. Moreover, it should be realized that when a zone becomes well developed, and has large amounts of a variety of different types of floor space in use, any cumulative effect is certain to dissipate and the law of attraction would probably become linear. Even with increased development the linear relationship would seem to be representative of the attraction condition, since a law of diminishing returns would tend to restrain any retail business from constructing more floor space if each additional square foot used attracted fewer people.

If this reasoning is correct, the linear law will only apply to the core of a CBD and will probably not be indicative of conditions in either a growing or deteriorating fringe. For this reason, it becomes necessary to define carefully the core area. Since the CBD limits for this study coincided with the traffic study and floor area survey information, clear definition of the core was not entirely satisfactory. Attempts were made, however, to utilize the technique developed by Murphy and Vance[3] to classify the CBD area in Philadelphia which had a relatively large and well defined CBD. Reference to the limits of application of the linear regression equation, based on the Murphy and Vance technique, is made later.

The fitting of a regression equation to a set of observations is a statistical technique described in a number of text books[4]. In this analysis use was made of a set of Gaussian multipliers to find the equation of best fit. By the use of this method values of the coefficients b_1, b_2, and b_3 and the constant k of Equation 1 were calculated. These coefficients provide estimates of the generation effect of the three types of floor space used, in terms of the number of people attracted per 1,000 square feet of floor area.

Results of the Analysis

One of the principal functions of this study was to determine whether a knowledge of CBD floor space would be useful in estimating the attraction of people to the city centre. As a typical example of the relationships obtained, Tables III and IV were prepared. Data for the other cities were prepared in a similar manner but in the interest of brevity are not included but are contained in a detailed report prepared by the authors[5]. Tables III and IV show the O-D zone number, the floor area in use in each of the three classifications adopted, the number of person destinations in each zone, as provided by the traffic survey, and the number of person destinations estimated by the regression equation.

At first glance it would appear that the estimates are far from perfect. However, the zones which show large errors are those attracting a relatively small number of trips. It was found that for nearly every city examined the zones which attracted the largest number of trips produced errors of less than 20 per cent. There is some reason to suggest that if the zones in Philadelphia had been more extensively grouped, better results would have been obtained. Alternatively, better results might well have occurred if a larger number of floor space types had been used. It was also found that the vast majority of zones having large errors of estimate were located on the edge of the CBD, and were most likely outside what might be termed the core, where the linear law could be expected to apply. As might have been expected there was a greater range of error shown between estimated and observed trips for zones in cities with considerable time difference between surveys. However, there still remained a reasonably distinct relationship between floor space and trip generation.

The development of a regression equation does not prove that variations in floor area use actually cause the difference in trip generation of a zone. Nevertheless, the existence of these relationships, and the fact that most people travel to the CBD to transact some form of business with an occupier of floor space, makes an inference of this kind highly probable. Thus it would appear that, if sound forecasts of future floor space use in the CBD can be made, estimates of person trips, based on the appropriate regression equation, can be of great aid to the highway planner.

Earlier reference was made to the limitations of the application of the linear relationships to those zones of the CBD which might be more properly termed the core by the Murphy and Vance technique. Support for this was indicated by the fact that the larger errors of estimate occurred in zones on the fringe of the CBD. Although an investigation of the core area of all cities would have been difficult, since certain necessary details were often missing, the Philadelphia CBD was sufficiently large and well detailed to permit the establishment of a boundary encompassing an area defined as CBD by the Murphy-Vance method. This area was, therefore, compared with the area in which the linear law appeared to apply (Table V). This analysis was complicated by the lack of coincidence between O-D study and floor-area survey zone boundaries, with the result that sensitivity was lost due to the need for zone grouping. Table V, however, indicates reasonable agreement between the area delimited by the Murphy-Vance method and those zones where the error produced by the linear equation was less than 20 per cent.

Comparison of Cities

An important aim of this study was to obtain a better understanding of travel habits for groups of cities. It was thought that similarities and differences in the prediction equations might be explained by city characteristics such as size, location, or predominant economic activity. The great variation in the cities studied is indicated in Table VI.

Table VII shows the various equations used to estimate trip generation in the CBD as determined by the regression analysis. Examination of Table VII indicates some extremely interesting similarities among the equations, particularly noteworthy in the case of Philadelphia, Detroit and Baltimore and, to a lesser extent, Seattle. The raw data received from Dallas and Vancouver were somewhat deficient in certain details which could explain the variations with regard to these equations[5]. In spite of these deficiencies, the equations for Dallas and Vancouver were, in a general way, similar to the others. Tacoma's equation, on the other hand, was quite different from those of the other cities analysed.

TABLE III

Floor space; Person destinations; Estimated Person destinations; and error in estimate— Philadelphia all CBD Zones

Regression Equation: $\hat{Y} = 14.602X_1 + 5.858X_2 + 1.276X_3 - 3,470$

O-D Zone	*Floor Space: 1,000's Sq. Ft.*			*O-D Person Destinations (24 hrs.)*	*Destinations Est'd Person (24 hrs.)*		
	Retail X_1	*Service —Office* X_2	*Manufacturing— Warehousing* X_3	Y	$\hat{Y}$	$\hat{Y}-Y$	*% Error*
0001; 0002	1,809	11,118	1,473	88,490	89,950	+ 1,460	+ 1.6
0003	41	2,130	144	28,860	9,790	−19,020	− 66
0005; 0006	4,366	6,811	2,290	103,690	103,100	− 690	− 0.6
0007; 0008	2,975	3,818	2,633	77,200	65,700	−11,500	− 15
0043	23	781	0	3,700	1,440	+ 2,260	− 61
0042	15	165	12	1,790	−2,270*		
0041	105	160	87	3,700	— 980*		
0063	86	720	612	2,540	2,840	+ 300	+ 12
0064	97	431	257	2,180	800	− 1,300	− 60
0009	2,684	441	1,706	36,590	40,480	+ 3,890	+ 11
0061	71	658	196	8,340	1,670	− 6,670	− 80
0062	174	1,172	196	6,260	6,190	− 70	− 1.1
0027; 0029; 0032	906	3,581	604	26,510	31,510	+ 5,000	+ 19
0045	346	1,484	281	4,550	10,630	+ 6,080	−134
0047	231	1,067	246	3,850	6,470	+ 2,620	+ 68
0082	92	2,783	1,642	13,660	16,270	+ 2,610	+ 19
0091	843	1,921	2,351	17,220	23,090	+ 5,870	+ 34
0073	300	491	1,502	3,270	5,700	+ 2,430	+ 74
0026; 0028; 0031	668	1,897	628	10,950	18,200	+ 7,250	+ 66
0023; 0025	558	1,703	252	9,540	14,980	+ 5,440	+ 57
0044	348	250	370	1,970	3,550	+ 1,580	+ 80
0046	383	226	325	1,940	3,860	+ 1,920	+ 99
0081	629	755	860	5,500	11,230	+ 5,730	+104
0052	440	2,360	3,779	23,430	21,600	− 1,830	− 8
0053	261	1,158	4,234	6,970	12,530	+ 5,560	+ 80
0051	242	223	565	2,190	2,090	− 100	− 4.5
0092	147	859	2,702	6,200	7,160	+ 960	+ 15
0072	154	277	227	2,030	690	− 1,340	− 66
0071	205	333	1,390	4,080	3,250	− 830	− 20
0022; 0024	176	344	150	2,690	1,310	− 1,380	− 51
0021	117	211	76	2,450	−430*		

*See comments in the text.

Variance of Estimate $S^2(y) = 30,178,700$

Standard Error of Estimate $S(y) = 5,490$ Person Destinations

Coefficient of Multiple Determination $R^2 = 0.960$

	X_1	X_2	X_3	K
95% Confidence Range of Equation Parameters	11.873 17.331	4.709 7.007	−0.693 +3.245	+2,120 −9,080

TABLE IV

Floor space; Person destinations; Estimated person destinations; and error in estimate— Detroit Central Business District Zones

Regression Equation:—$\hat{Y} = 13.918X_1 + 4.613X_2 + 1.717X_3 - 2,280$

O-D District	*Floor Space 1000's Sq. Ft.*			*O-D Person*	*Est'd Person*		
	Retail X_1	*Service —Office* X_2	*Manufacturing— Warehousing* X_3	*Destinations (24 hrs.)* Y	*Destinations (24 hrs.)* $\hat{Y}$	$\hat{Y}-Y$	*% Error*
00	5,400	2,721	86	85,850	85,580	− 270	− 0.3
01	2,454	14,162	1,573	99,670	99,900	+ 230	+ 0.2
11	480	3,259	3,348	25,260	25,180	− 80	− 0.3
12	440	1,494	1,154	8,210	12,710	+ 4,500	+ 55
13	140	761	10	2,760	3,200	+ 440	+ 16
15	193	1,968	789	11,800	10,840	− 960	— 8
17	426	2,680	721	19,030	17,250	− 1,780	— 9
19	102	1,330	1,578	10,000	7,980	− 2,020	— 20

Variance of Estimate $S^2(\hat{Y}) = 7,804,000$

Standard Error of Estimate $S(\hat{Y}) = 2,790$ Person Destinations

Coefficient of Multiple Determination $R^2 = 0.997$

	I_1	X_2	X_3	K
95% Confidence Range of Equation Parameters	12.086 15.750	3.864 5.362	−1.392 +4.862	+6,180 −10,740

TABLE V
Philadelphia Central Area.

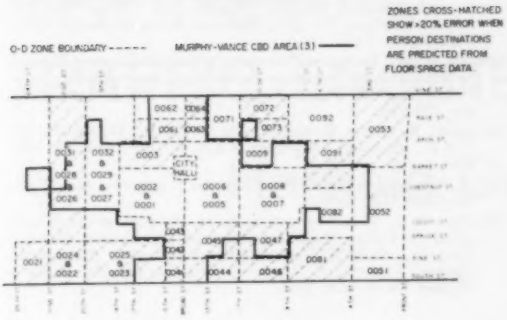

ZONES CROSS-HATCHED SHOW >20% ERROR WHEN PERSON DESTINATIONS ARE PREDICTED FROM FLOOR SPACE DATA
O-D ZONE BOUNDARY
MURPHY-VANCE CBD AREA (3)
CITY HALL

TABLE VI
Location, Population and Service Classification of seven Cities Analysed

Metropolitan Area	*State or Province*	1950 *Population*	*Service Classification**
Philadelphia	Pennsylvania	3,671,048	Finance, Insurance and Real Estate
Detroit	Michigan	3,016,197	Manufacturing
Baltimore	Maryland	1,337,373	Diversified
Seattle	Washington	732,992	Strongly Financial, Insurance, etc.
Vancouver	British Columbia	600,000	—
Tacoma	Washington	275,876	Public Administration and Finance
Dallas	Texas	614,799	Very strongly Financial and Wholesaling

**Nelson, J., 'A Service Classification of American Cities'* Economic Geography, *XXXI, No.* 3, (*July* 1955) *pp.*189-210.

TABLE VII
Equations governing the Attraction of Persons to Areas in the CBD's of seven Cities on the basis of Floor Space

City	*Regression Equation*
Philadelphia, Pa.	$Y = 14.602X_1 + 5.858X_2 + 1.276X_3 - 3470$
Detroit, Mich.	$Y = 13.918X_1 + 4.613X_2 + 1.717X_3 - 2280$
Baltimore, Md.	$Y = 12.871X_1 + 4.524X_2 + 1.343X_3 - 1080$
Seattle, Washington	$Y = 13.678X_1 + 4.382X_2 + 0.152X_3 - 200$
Vancouver, B.C.	$Y = 14.322X_1 + 10.534X_2 + 3.670X_3 + 1560$
Tacoma, Washington	$Y = 7.709X_1 + 2.493X_2 - 17.692X_3 + 3590$
Dallas*, Texas	$Y = 16.191X_1 + 3.546X_2 + 12.265X_3 - 8570$

**The floor space information in Dallas was estimated from a map and, as a result, cannot be classed as accurate; consequently this equation is included only to show the rough similarity between it and the first three.*

The fitting of a regression line provides estimates of an unknown set of 'true' values. Therefore, equations can in no way be presumed to be true equations representing the relationship. Rather, they are simply estimates of the situation. Nevertheless, the similarity of the equations for Philadelphia, Detroit and Baltimore could, in fact, mean that they are all estimates of one true equation and that the attraction of people to the central zones of these cities is governed by a single law. Although the X_3 coefficient in the Seattle equation tends to make it appear different from the three previously mentioned, the extent of this difference is not sufficient to rule out the possibility that the Seattle equation is the same as for Philadelphia, Detroit and Baltimore.

Fig. 3. *A business street in the centre of Philadelphia.*

Before accepting this hypothesis it was thought that there might be other characteristics of the city or city centre which might exert an influence on trip generation. For this reason the equation coefficients were compared on the basis of various indices such as: population, retail floor space per head, retail floor space per $1,000 of retail sales, office space per head and per worker in selected service trades, and manufacturing-warehousing space per head and per worker in production and wholesale activities. These comparisons failed to show any trend and seemed to lend power to the suggestion that for large cities irrespective of their size, location, or economic activity, the equations developed are estimates of a single general equation. In this latter comparison it was found that in Vancouver the ratio of service workers per 1,000 square feet of service-office space was significantly higher than for all other cities. This ratio may reflect the difference between Canadian and American census data, and it seems reasonable to suggest that it may possibly account for the high service-office generation coefficient in the Vancouver equation. No definite decision can be made regarding Tacoma, largely due to the fact that its CBD consisted of only five zones and therefore no great confidence can be placed in the estimates. There does appear to be, however, sufficient difference between the Tacoma equation and all other equations to suggest that trips to this city centre may be governed by an equation different from that for the other cities studied. Since Tacoma was the only one studied with a population less than 600,000 persons, it may well be representative of another group of cities.

Some thought must be given to the constant term in the equations. In a mathematical sense, the presence of this term signifies that the extrapolated regression line would not pass through the origin. The effect of the constant term on the estimates is generally quite small, and thus the difference between Philadelphia and Seattle is not as great as would appear. Nevertheless, reference to Table III shows that for some individual zones, where the trip production was quite low, the constant term served to render the result meaningless. In general, this merely indicates that the linear law cannot be applied to all zones but should be restricted to well developed central zones with relatively high trip generations.

Conclusions

This investigation represents only an introduction to what may well be a profitable field of study. On the basis of the results obtained there is some reason to suggest that the number of people attracted to an area in a city's centre is closely related to the area of floor space used for various purposes in the section of the CBD considered. Information of this kind, used in conjunction with sound economic floor space forecasts, should provide reasonably accurate estimates of the future travel to a city's CBD zones.

Even though these results encompass a relatively small number of cities, there is some indication of similarity among the large cities studied with regard to the generation effect of the CBD. As more of these equations are developed it may become possible to estimate equations which will be representative of a group of cities and, with this tool, it will then be possible to estimate person trip generation in cities where no O-D data are available.

The similarities of the equations for this relatively small group of cities should be of considerable interest. These similarities are particularly apparent in the cases of Philadelphia, Detroit, and Baltimore and, to a lesser degree, for Seattle and Vancouver. To some extent this tends to lend strength to the concept of forecasting suggested by this study. There is also some indication that, for the larger cities at least, development which produces an increase in floor space is accompanied by very minor changes in rate of trip attraction.

In the comparison of cities it is interesting to note that the use of person movements, irrespective of mode of travel, has indicated great similarities between travel to the centre of Detroit and Philadelphia. These similarities would have been masked by differences in car ownership and use in the two cities had mode of travel been introduced as a variable.

It is hoped that the feasibility of predicting the number of people attracted to the centre on the basis of floor space, as suggested by this study, will stimulate others to extend this work. Extension of the work to include the distribution of the origin end of the trip would certainly be in order. If this can be accomplished it may then become possible to synthesize future travel patterns, based on land use maps and floor space data and thus eliminate, or at least reduce, the need for costly O-D surveys.

REFERENCES

[1]Horwood, Edgar M. and Boyce, Ronald R. 'Measurement of Central Business District Change and Urban Highway Impact.' *Bulletin No.* 221, Highway Research Board, 1959, Washington, D.C.

[2]Silver, Jacob. 'Trends in Travel to the Central Business District by Residents of the Washington D.C. Metropolitan Area, 1948 and 1955.' *Public Roads*, Vol. 30, No. 7, April 1959, pp. 153-176.

[3]Murphy, Raymond E. and Vance, J. E., Jr. 'Delimiting the C.B.D.' *Economic Geography* XXX, 3, July 1954, pp. 189-222.

[4]Volk, William. 'Applied Statistics for Engineers.' New York, McGraw Hill, 1958.

[5]Harper, B. C. S. and Edwards, H. M. 'A study of the Generation of Person Trips by Areas in the Central Business District.' Ontario Joint Highway Research Programme, Queen's University, Kingston, Ontario, Canada, Research Report No. 9, May 1960.

ACKNOWLEDGMENTS

The study reported here was undertaken in the Civil Engineering Department of Queen's University, Kingston, Ontario, under the sponsorship of the Ontario Joint Highway Research Programme, and acknowledgment is made to the officials of the Ontario Department of Highways who offered assistance and encouragement to the authors. Acknowledgment is also made to the State Highway Department in the United States and to the City Planning Departments, in both Canada and the United States, who contributed data. Too many contributed to permit individual listing but without their co-operation this investigation would not have been possible.

Next Months Contributions

include :

Traffic Studies at a Rural Junction

B. G. Manton, Imperial College, London.

Doncaster By-Pass

Col. S. Maynard Lovell, County Engineer and Surveyor, West Riding of Yorkshire.

Design of Traffic Intersections

Dr. Ing. Max-Erich Feuchtinger.

Planning Transport in the Pittsburgh Region

Louis E. Keefer, Study Director, Pittsburgh Area Transportation Study.

Safety Straps

Brigadier R. F. E. Stoney, Director-General, RoSPA.

COURSES IN TRAFFIC ENGINEERING

Hatfield College of Technology

by G. J. Hussey

WITH local authorities in Hertfordshire spending more and more time and money grappling with ever-worsening traffic problems, it was, perhaps, natural enough that Hatfield College of Technology should enter the field of Traffic Engineering.

The Civil Engineering section of the college has always been excellently equipped, but somewhat small. In the last year, however, the scope of Civil Engineering activities there has considerably widened. Mr. D. R. Samson, Head of the Engineering Department, sought and received the support of nearby local authorities for the inclusion of Traffic Engineering in this programme of expansion.

Although at that time the college had no staff specifically qualified in Traffic Engineering, plans for the first course were pushed forward. Apart from the mathematics lectures, outside experts were invited to deliver all of the twenty-two-hour evening talks, which were arranged at weekly intervals. Wholehearted support was forthcoming from the Ministry of Transport, the Road Research Laboratory, and the L.C.C., all of whom supplied authoritative lecturers. Professor Fisher Cassie and Mr. Granville Berry also accepted invitations to speak.

Opened by Dr. Charlesworth in October 1960, the course covered Street Lighting, Road Signs, Instrumentation and Measurement of Traffic Behaviour, Origin-Destination Surveys, Surface and Multi-storey Parking, Control of Traffic, Surface Characteristics and Skidding, Pedestrian Behaviour and Accident Statistics, Road Crossings, Capacity of Intersections and Mathematics. Intense interest from authorities in Hertfordshire and Bedfordshire resulted in a total enrolment of over 80, and an average attendance of nearly 70 reflected the success of the series.

At the end of the course, students were asked to state whether or not they would be interested in an extension in the 1961-62 session. This extension would cover the remaining subjects in the syllabus for the Institution of Highway Engineers' Diploma in Traffic Engineering. Over 50 indicated that they would attend, and several are planning to sit for the Diploma. This follow-up course of eleven lectures will commence at the end of September.

On examining the answers to the questionnaire, it was found that a large number of students suggested a course which included practical work. This automatically meant a full-time course. A great many authorities were contacted in order to determine the support that would be forthcoming for a full-time course of eight weeks. Many indicated support in principle but felt unable to spare men for such a long time. However, the replies received warranted the next stage of expansion, and a four-week full-time course is being arranged for March 1962.

The first member of staff with Traffic Engineering experience has been appointed, and further staff expansion and equipment expenditure is envisaged, whilst the Mathematics, Science and Electrical Departments will assist where necessary. Even so, the college must for some time continue to rely heavily upon the generous co-operation of other bodies.

In deciding upon the subject matter for the full-time course, emphasis is being placed upon practical work, and all students will carry out a carefully planned project.

It would appear that the steady growth of Traffic Engineering at Hatfield College of Technology is assured. It is hoped that both evening and short full-time courses will run regularly, whilst, as a long-term policy, Traffic and Highway Engineering will be offered as a regular Higher National course to give exemption in this subject from the Institution of Civil Engineers examination.

The successful introduction of Traffic Engineering at Hatfield is the result of friendly co-operation between local authorities, government bodies, and college personnel; a co-operation which, it is hoped, will play no small part in enlarging the knowledge of many of the men whose job it is to try to solve the mounting traffic problems of this country.

LETTER *to the* EDITOR

from F. B. LOW, *Secretary, Britain's Buses*

YOUR leading article, Public Transport in this month's issue contains an admirable exposition of principles which ought to be followed by planners of our roads and cities, summed up in your phrase: 'A fair balance between maintaining traffic flow and the needs of public transport.'

I think, however, that the attitude of the bus operators who are united in the Britain's Buses Campaign has not been fully understood. For instance, you refer 'to the impression of opposition to re-development plans in general, and to steps taken to improve traffic flow in particular, wherever they require re-adjustment to present circumstances.' This is an impression that we certainly did not mean to convey. Our complaint is simply that only too often in the past planning has been carried out without taking into account properly, or at all, the views of either bus operators or the Traffic Commissioners, and that planning is even now proceeding on the same lines. In the result 'the requirements of public transport' have *not* in fact been 'given full consideration'.

Similarly, bus operators do not oppose the provision of adequate car parking facilities. They merely ask that 'adequate' shall be taken to mean that car parks should not be so large and so cheap, having regard to the size and traffic situation of the city or town concerned, that public transport is frustrated from doing its own job properly.

Again, as to bus stations, although I am not quite sure that I understand your use of the word 'requirement' ('the requirement that off-street bus stations be used in town centres . . .'), busmen do not oppose all bus stations as a matter of policy; in some cases they may be desirable. Rather they would say that a strong case, certainly based on more than mere 'tidiness', should be made before departing from the basic principle that the proper place for buses to pick up and set down passengers is in the main streets, as close as possible to the points where they want to travel to and from. Three minimum conditions would be: (1) that the bus station is sited at a natural terminal point from the traffic point of view, e.g. next to a railway station or a shopping centre; (2) that the amount of additional walking imposed on passengers is very slight; (3) that it is established satisfactorily that the capital charges of the bus station, which are reflected in increased fares, are justifiable.

11 Lower Regent Street,
London, S.W.1.

Fig. 1. The main one-way routes.

TOTTENHAM COURT ROAD ONE-WAY TRAFFIC AREA

Fig. 2. The Scheme in operation at Princes Circus.

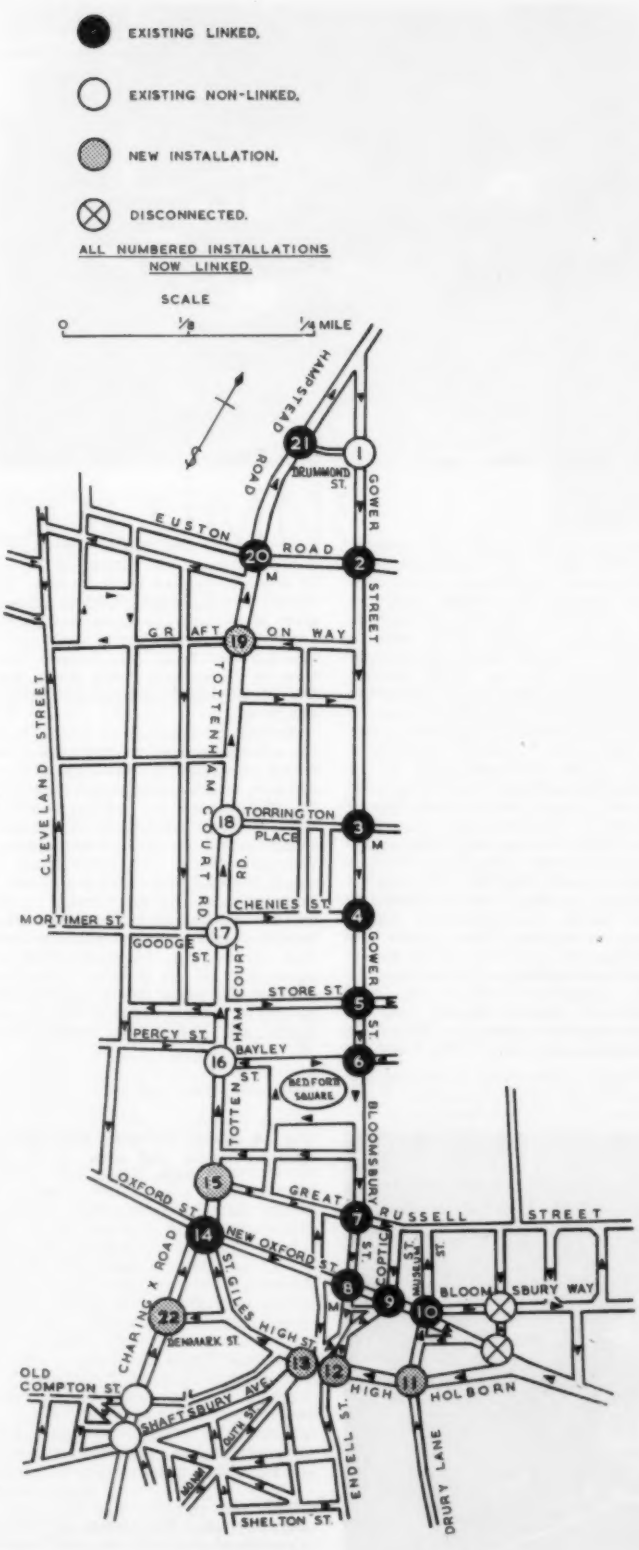


Fig. 3. Plan showing the traffic signals.

TRAFFIC along Charing Cross Road-Tottenham Court Road-Hampstead Road had for many years been subject to delays due to its volume and also a number of junctions along the route, where in many cases there was a considerable amount of right-turning as well as cross traffic. The London Traffic Management Unit of the Ministry of Transport, in collaboration with the Metropolitan Police and the four highway authorities concerned (City of Westminster and the Metropolitan Boroughs of Holborn, St. Marylebone and St. Pancras) investigated the possibility of a one-way traffic system to improve conditions by utilizing Gower Street and Bloomsbury Street as a southbound route complementary to northbound working in Tottenham Court Road and Hampstead Road. As a result of these investigations a decision was made to introduce such a system on an experimental basis. The main one-way routes are shown in Fig. 1 and, amongst other changes, it will be seen that New Oxford Street and Bloomsbury Way became one-way eastbound with High Holborn, St. Giles High Street and Denmark Street one-way westbound.

S.G.E. Signals were principally involved in the necessary modifications and additions to the Autoflex Signals in the area. There were twenty existing vehicle-actuated signal installations and two of these were switched out of service as they were not required under the new conditions. The remainder were modified to suit one-way working and this generally involved the erection of additional signals and new illuminated box signs related to prohibited turns, together with detectors to cover the whole width of one-way streets. New cables had to be laid to connect this extra equipment. In some cases, however, fairly expensive modifications of the layouts of the road junctions were necessary to the success of the scheme and consequently the signal installations were almost completely remodelled. Examples were Nos. 9, 10 and 14 of which No. 10 was changed from a signalled pedestrian crossing to a signalled junction. The 3-phase controller providing an early cut-off at No. 17 was modified to provide a late start facility and interchanged with the controller at No. 1.

Six additional sets of signals were installed, five of these being vehicle-actuated signals at junctions and the sixth—a signalled pedestrian crossing replacing a zebra crossing, frequently used by blind people, which was often controlled by a policeman. The two new installations at Princes Circus (Nos. 12 and 13) are of particular interest and are illustrated in Figs. 2 and 3. A double gyratory system existed with a scissors crossing in the middle, but it was thought that the anticipated traffic flow, now mainly southbound,

could best be handled if the two parts of the road were completely separated, avoiding the scissors conflict; also kerbs were modified. This formed two junctions at the southern end which could then be controlled by signals.

In the 10 weeks allowed for the installation and modification work required, S.G.E. Signals provided and fixed approximately 77 new road vehicle detectors, 70 new signal heads, over 7,000 yards of multi-core cable and fitted some 114 internally illuminated box signs. In addition, 60 existing signal heads were moved or modified.

The operation of the signal controllers obviously had to be co-ordinated so that traffic would be able to flow as freely as possible and it was decided to interlink the 22 installations which are numbered in Fig. 1. Twelve of these were already interlinked as groups or part of a group of four Autoflex Progressive systems. Installations Nos. 7, 8, 9 and 10 formed one group, connected to a master controller at No. 8, and Nos. 3, 4, 5 and 6 formed another group, connected to a master controller at No. 3, whilst Nos. 2, 20 and 21 together with four other installations (not affected by the one-way experiment) formed a further group connected to a master controller at No. 20. Installation No. 14 formed part of the Oxford Street progressive system, being connected to the master controller at Oxford Circus, but it was disconnected from this and connected to the master controller at No. 3.

Interlinking equipment was included in the controllers for the new installations and added to those at the existing installations Nos. 1, 16, 17 and 18. All of these controllers were connected by cables to the existing master controllers in the following manner:

Nos. 1 and 19 connected to master controller at No. 8.

Nos. 11, 12 and 13 connected to master controller at No. 20.

Nos. 15, 16, 17 and 18, and No. 14 as already mentioned, connected to the master controller at No. 3.

The controller at No. 22 was closely coupled to that at No. 14.

Fig. 4.

The operation of the three master controllers had to be co-ordinated to obtain correct interlinking of the controllers connected to them, and the master controllers at Nos. 8 and 20 were therefore connected by cable to that at No. 3, which became the governing controller for the whole system. Equipment was fitted in the controllers to ensure that the cycle control units of those at Nos. 8 and 20 operated in step with that at No. 3. Flexible progressive linking of all the installations in the area was thus achieved to give a general speed of 20 m.p.h. with a cycle time of 65 seconds. The governing controller at No. 3 was, however, originally equipped with a traffic integrator, which is a means of recording the total number of vehicles passing a selected point or points during successive five minute periods, comparing these totals and modifying the cycle time of the master controller accordingly. In this case, the traffic integrator records the total number of vehicles passing over the northbound detectors at No. 18 and the southbound detectors at No. 3 and the cycle time of the master controller is varied between the limits of 60 and 75 seconds, in five second steps. The shortest cycle time of 60 seconds is given when the traffic integrator records a traffic flow equivalent to less than 720 vehicles per hour, the longest cycle time of 75 seconds being given when the recorded flow exceeds 2,016 vehicles per hour.

As will be appreciated from Fig. 1, the scheme covered a considerable area which extended into the City of Westminster, and Metropolitan Boroughs of St. Marylebone, St. Pancras and Holborn, a large proportion of the work being carried out in the last mentioned Borough. Work was commenced towards the end of February and was so arranged that the final major modifications and linking of the signal installations could be made during the week-end preceding May 1. The co-operation of all parties concerned enabled the whole of the signal installations to be switched into service while traffic was lighter, on Sunday, April 30.

Fig. 4 *above. Princes Circus showing changed layout and some of the new traffic signals.*

Fig. 5 *left. Intersection of Charing Cross Road, Oxford Street and Tottenham Court Road at St. Giles Circus with one-way traffic proceeding Northwards.*

GLASS FIBRE STREET LIGHTING COLUMNS

by E. H. AUSTEN

Fig. 1. Children carrying glass fibre column showing its very light weight.

IT will be generally agreed that the use of plastics and reinforced synthetic resins have virtually revolutionized production of certain industrial and domestic utensils. Similarly, the use of such materials in producing a column for street lighting purposes presents an interesting and unique diversion from the conventional materials used for this purpose.

The idea of using polyester resin bonded glass fibre for this purpose is not new, but the practical difficulties involved presented a considerable number of problems:

(1) Could a column of adequate strength be manufactured economically.
(2) Could a satisfactory surface finish of the exterior be produced free from blemishes and air pockets.
(3) Would the unit be strong enough when control gear compartment door was cut out.
(4) Would the unit withstand impact, abrasion and wilful damage.

The first factor which had to be considered, before any development could be made, was to decide on the best shape and size of column which could be produced. Factors governing this shape included strength, size of control gear compartment, practical considerations as to method of manufacture and aesthetic appearance. Bearing all these factors in mind it was decided to produce a single taper tube, 16 ft. overall, 9 in. o.d. at large end, tapering to approximately 3 in. diameter at apex. This shape appeared theoretically to comply with all the above requirements and it then remained to decide what wall thickness was required.

Using the above dimensions, and as much of the relevant information available in B.S.1840, 1952, Section 19 (b) for the permissible temporary deflection of steel columns, the following formula was derived, in conjunction with Messrs. B.I.P. Chemicals, Ltd., of Oldbury:

$$T = \frac{27r^3p}{E\pi b^3 y}\left[Rb\left\{\frac{16}{27} - \frac{\log e^3}{3}\right\} + A\left\{\log e^3 - \frac{8}{9}\right\}\right]$$

$$T = \frac{27 \times 90^3 \times 10}{144 \times 2 \times 10^6 \times \pi \times 4^3 \times 3}\left[90 \times 4\left\{\frac{16}{27} + \frac{\log e^3}{3}\right\} \times 288\left\{\log e^3 - \frac{8}{9}\right\}\right]$$

$$T = 0.158''$$

Where T = Wall thickness in inches.
h = ½ height in inches = 90″.
p = p = Wind Pressure = $\frac{10}{144}$ lb. per sq. inch.
E = 2 × 10 inch lb.
b = Bottom Radius = 4″.
y = Permissible Deflection = 3″.
A = Area of Lantern = 288 sq. inches.

It was appreciated that this value was purely theoretical, as it was virtually impossible to obtain an accurate value of 'E', as this varies with the type of laminate and resin/glass ratio.

Using this as a basis, a unit was manufactured with approximately $\frac{3}{16}$ in. wall thickness. The results obtained proved to be very encouraging and a presentable unit was produced. The surface finish of this unit left much to be desired but it served to prove the theory of construction as, when it was tested under varying horizontal dead loads, the deflection was found to be within the limits prescribed. (*See* curve '*A*', *Fig.* 2). Further tests, however, showed that the column was too flexible for practical use as it would 'whip' too freely under comparatively small impact. It was felt, therefore, that it required stiffening in some manner. Further experiments were carried out to achieve this and also improve the surface finish. After many months of development a unit was produced with a laminate of modulus 'E' considerably higher than previously and this served not only to reduce 'whip' but also to reduce temporary deflection under equivalent load. (*See Curve* '*B*', *Fig.* 2.)

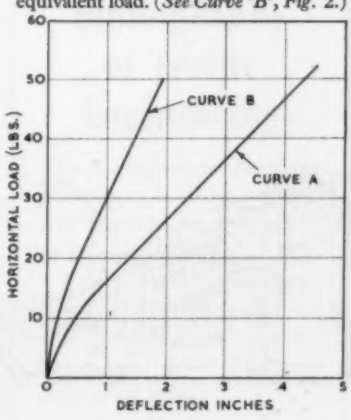
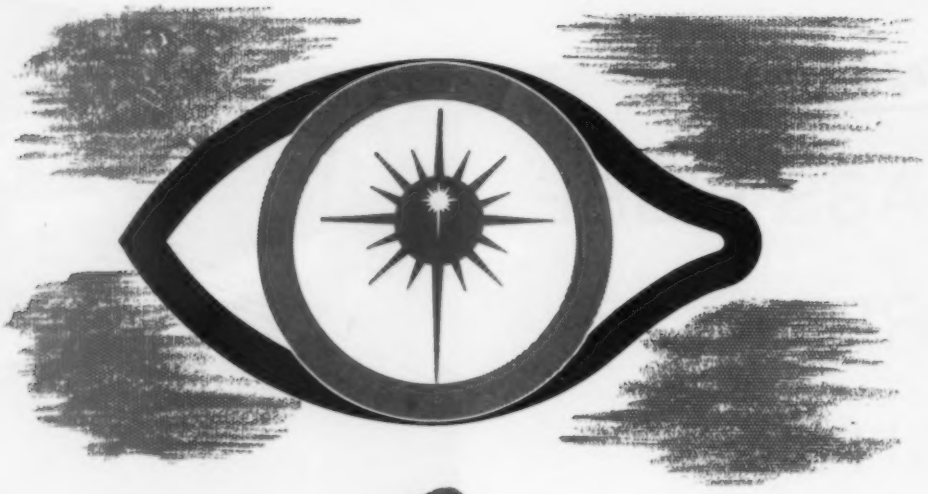


Fig. 2.

TEC179 for further information



OPTICAL SCIENCE IN STREET LIGHTING

By controlling the distribution of light within strict, predetermined limits, HOLOPHANE refractors and reflectors provide the ideally flexible medium for modern street lighting projects. The full range of HOLOPHANE refractors and lanterns covers all needs for both Group 'A' and 'B' roads, with many different designs to overcome specific problems of siting and light distribution. Consequently, light sources can be scientifically applied to simulate an unbroken surface luminance with adequate background brightness. HOLOPHANE units are constructed to unique prismatic designs fully controlling the lamp output and embodying the detailed optical research of HOLOPHANE scientists for over sixty years. Please write for details of the complete range of HOLOPHANE street lighting units.

HOLOPHANE LIMITED

SCIENTIFIC ILLUMINATING ENGINEERS

ELVERTON ST. WESTMINSTER, LONDON, S.W.1

'Phone: VICtoria 8062 'Grams: Holophane, Sowest, London

The unit produced to date appeared to fulfil all the requirements of points 1, 2 and 3, mentioned above, and it only remained to submit the column to tests, in order to ascertain its performance under impact, etc., point 4.

For this purpose a series of tests were arranged—children up to sixteen years old were instructed to try and damage the column by any means they could think of. Further a car was to be backed into a column, scraped alongside it and finally, run head-on into a column which had been firmly concreted into the ground.

The children who performed the first part of the test were most ingenious in their selection of devices to damage the column and bricks, bottles, knives, air-guns, hammers and catapults were all used and, finally, the two units given to them ended in a local canal. To say that no damage resulted from the attention of these children would not be true but it was only after sustained effort that they were able to make any serious impression on the column. The bricks, knives, etc., resulted in surface scratches and abrasions, which were not detrimental, but the hammer, persistently used in one spot, resulted in a large dent. When recovered from the canal after three weeks, it was found that the columns would still carry a lantern with perfect safety.

The most practical tests, with the car, resulted in a performance which was beyond the hopes of the most optimistic. Backing into it, at approximately 5 to 10 m.p.h., produced hardly any impression whatsoever. Scraping it, at approximately 30 m.p.h., with wings, door handle, etc., merely made it shudder but it remained standing and showed very few marks. The final test, running into it at approximately 15 to 17 m.p.h., tilted the unit over at approximately 5 degrees to horizontal, and cracked the concrete foundations. (*See Fig.* 3.) The car used was a 1933/34, Ford 8. This car is of fairly heavy construction, built on a chassis, and is fitted with a heavy pressed steel plate behind the radiator grill and carries the fixed starting handle. This plate took most of the impact and was more seriously damaged than the column. The main damage to the column occurred when the car was backed off. The bumper bar, which had broken, became wedged in between the door and its housing and a small cut was made into the glass fibre laminate by the jagged edge.

It will be appreciated that if a column made of any material is hit hard enough it will collapse but it is of extreme importance to determine exactly how it will fall and, furthermore, it should remain in one piece, if possible, and not throw the lantern or bracket-arm in falling. A glass fibre column was hit at 35 m.p.h. with the front wheel of the car used for these tests. It naturally went down, bending at the base of the control gear compartment and, in fact, when the car was backed off, it resumed an angle of approximately 45 degrees to the vertical. The first test, however, resulted in the bracket-arm and lantern being thrown a considerable distance forward, the former snapping off where it was screwed into the spigot, moulded into the top of the column. Modifications were made to this fixing arrangement, simply by counterboring the spigot so that the end of the thread on the bracket-arm was approximately 1 in. below the top of the spigot. This simple modification had the desired effect and in no subsequent tests did the bracket-arm or lantern part from the column when it collapsed.

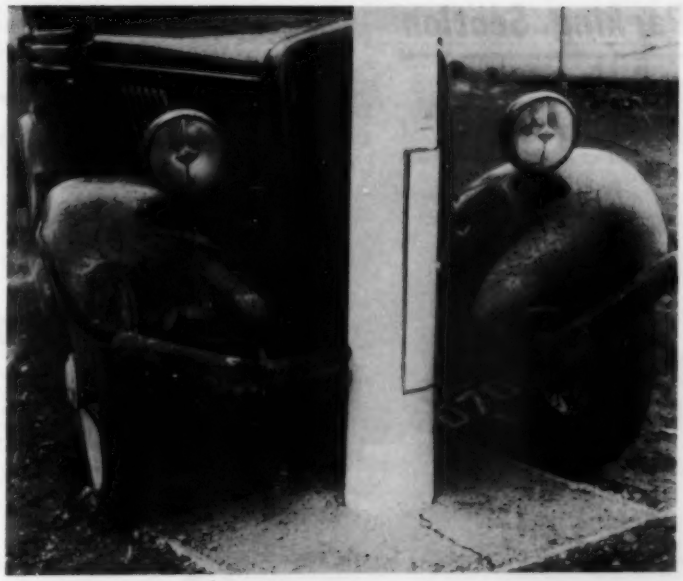


Fig. 3. *Damaged vehicle following impact with lighting standard, which remained erect.*

A further interesting fact came to light during these impact tests. The baseboard, to carry control gear, was cemented into the columns and not screwed in any way and, in no instance, did the board come away or split, even under the severest blows. Consequently, if the columns had been serviced, then the supply cable would merely have bent below the cut out and not split the cut out unit, as sometimes occurs with other types of column.

Fig. 3, shows the comparatively small amount of damage sustained by the vehicle which, unlike the modern car, was fairly solidly built. It is appreciated that the driver expected the impact but, even so, not one window or lamp glass was broken. It is apparent that this type of column absorbs a larger proportion of the impact shock, thus minimizing the overall damage.

Following this exhaustive testing of the columns, it was felt that the unit could be marketed with confidence.

Conclusion

The advantages claimed for glass fibre columns over conventional materials may be summarized, as follows:

(1) Lightness in weight—only 45 lb. Easy and cheap to install.
(2) Impervious to any corrosive element.
(3) Infinite choice of colour, which is permanent throughout the life of the column.
(4) Control gear compartment of maximum size, to accommodate any type of Class 'B' control gear and cable termination.
(5) Column will withstand considerable impact but, if demolished, personal risk and damage to vehicle involved is greatly reduced.

Finally, the user of columns of any type is also interested in price. Obviously the price for a unit can only be given in a firm quotation but, as a general rule, the cost of a glass fibre unit is a little more than a good quality concrete or steel unit and about the same as aluminium, but, if erection and maintenance costs are taken into account, the overall cost compares favourably.

This article was prepared specially for TRAFFIC ENGINEERING & CONTROL *by A. C. Ford, Ltd., Dudley.*

Bibliography of Traffic Engineering

The Bibliography recently published in this Journal will shortly be published in pamphlet form.

Copies may be obtained from the Editor, price 9d. post free. For orders of 50 or more, price 6d. per copy post free.

Car park with capacity for 2,200 vehicles at West Park Rapid Transit Station, Cleveland, showing car pick-up and drop-off lanes for easy interchange between public and private transport.

Community Parking Programme

by James B. SAAG,
Traffic Engineer, De Leuw, Cather & Company, Consulting Engineers.

Extracts from a paper on Financing and Administration of Community Parking Programmes presented at the University of Illinois Traffic Engineering Conference, Urbana, Illinois.

SOLUTION of the parking problem calls for money, and those who have money to lend want assurance that parking lots and garages in which they invest are economically sound ventures, and that they will be properly managed. These investors look to traffic engineers as experts on such matters.

Lack of parking space has been blamed for many community problems including congestion, decentralization, deterioration, loss of tax revenue, and even ulcers. The traffic engineer is blamed, in turn, since the public is inclined to think that the person responsible for moving traffic on the street should also be responsible for moving it off the street.

The prerequisite to a parking pr - gramme for any city is the determination through established traffic engineering methods of a deficiency in the existing supply of parking spaces. In many instances, the severity of a parking problem has been exaggerated by over zealous merchants and civic organizations. An engineering survey should be made, therefore, by someone with an objective viewpoint, as well as the proper training and experience. This may be a local or state agency, or a consultant. The survey determines the nature and scope of the problem before the community plunges into an off-street parking programme. It is often possible to correct minor deficiencies through such simple devices as revision of kerb parking regulations.

In many American cities—particularly in older sections of the country—established business districts have begun to deteriorate in the wake of decentralization. Since a large portion of the city's tax base is usually concentrated in its central business district, the revitalization of this area is an important responsibility of the municipal government. Except in rare instances, however, additional parking facilities alone will not bring about this rebirth. A comprehensive programme should therefore be developed, including improvement of traffic facilities, public transport and general appearance of the area as well as provision of an adequate supply of parking space.

Financing

Having determined the nature and scope of the problem, and developed the parking requirements of a particular area, the next step is to estimate the cost of a satisfactory solution.

To the individual driver, the question is simple. Is he going to have to pay for parking his car, or is someone else going to pick up the tab (and pass the cost on to him in some hidden and painless way)? The answer is important and closely related to the overall success of a parking programme.

The question of who is going to pay for parking facilities, when faced by a city administration, takes on an altogether different meaning. No amount of legerdemain will make it seem less real. It demands to know to what extent if any, municipal funds and resources are to be obligated for off-street parking. It asks whether private enterprise can be encouraged to provide the needed facilities or whether some governmental agency must find funds for this purpose. Finally, it asks what is the best method of public financing or assistance, if such is required.

The three basic sources of funds to finance new parking facilities—private investors, local government or a combination—should be analyed with consideration of local conditions to determine which best meets the requirements in each situation.

There are many ways in which the local government can encourage private investment in off-street parking facilities. The Motor Vehicle Parking Agency in the District of Columbia for example, has made data obtained from parking surveys available to private operators for use in planning new facilities. Urban renewal programmes also afford the opportunity to assist private parking developers in acquiring suitable sites which, otherwise would be prohibitively expensive. In St. Louis, Missouri, approximately 2,400 off-street parking spaces are proposed to be built in conjunction with three large apartment buildings in a downtown renewal area. The spaces, to be available to workers and visitors in the area as well as to tenants, will be financed by private investors.

There are other situations, however, wherein the powers or resources of public agencies are required to accomplish a particular project. The use of eminent domain is sometimes the only feasible way in which to assemble a site required for parking. In addition, construction of parking facilities beneath public parks or squares is often possible only if done by the local government. Even in these situations, the desired result can usually be achieved through the combined effort of governmental agencies and private developers.

Development of off-street parking facilities by private interests also includes, of course, provision of customer, private and employee parking spaces by individual merchants or property owners. Many facilities of this type have been built in conformance with zoning requirements. Although most up-to-date zoning ordinances require provision of a specified number of off-street parking spaces in conjuction with various types of new development, the requirement is often inadequate to meet peak demands. In addition, zoning regulations are not retroactive and have very little effect in older business districts where the parking problem is most acute.

Financing by Municipal Government

Municipal governments have taken the initiative, in many instances, to provide financing for needed parking facilities. These programmes have included the forthright use of public funds, as well as the use of municipal borrowing powers.

Little need be said about the use of general funds to finance parking facilities. Since most communities operate within tightly planned budgets, it is unusual if surplus funds are available in sufficient quantity for such purposes. When they are, however, the procedure is simple and the desired result is achieved in the least possible time.

Use of municipal borrowing power has been the most popular method of governmental financing as related to off-street parking facilities. This has been accomplished, in most cases, through sale of either revenue or general obligation bonds. The full faith and credit of the municipality is pledged toward repayment of principal and interest on general obligation bonds. Revenue bonds are payable both as to interest and principal solely from the net income derived from certain specified sources The principal source of income is usually the facilities constructed with the bond proceeds, but income from kerb parking meters has also been pledged in revenue bond financing to make the offering more attractive. The main advantage of financing through use of general obligation bonds is the low interest rate usually obtained. There are further savings in financing cost and in interest during construction.

Lease of sub-surface rights in public areas has also been widely used. A notable example is Pittsburgh's Mellon Square Garage where sub-surface rights were leased to the developer for a period of 38 years. Mellon Square Garage, Inc., paid the entire cost of constructing the 890-space underground garage while development of the park above was financed from other sources. Upon expiration of the lease, the parking garage will be turned back to the Pittsburgh Parking Authority.

The City of Baltimore is considering sale of sub-surface rights below pedestrian parks and plazas in the 22-acre Charles Centre downtown redevelopment area. It is expected that the value of these development rights will be computed on the basis of the re-use value of the properties acquired with a proportionate amount assigned to both the surface and sub-surface development.

The many variations in methods of financing clearly indicate that no single formula can be developed which will satisfy every need. Much depends on the scope of the project as well as its revenue producing capabilities. In addition, such items as state and local legislation, prevailing interest rates, municipal credit ratings, and projections of future development must be thoroughly investigated.

Administration

Administration of community parking programmes has been assigned, in many instances, to the realm of the traffic engineer. The scope and nature of the assignment depends to a great extent on whether the municipality, itself is the owner or operator of off-street parking facilities.

Even in communities where all off-street parking facilities are privately owned or operated, the municipal government has an administrative responsibility. Regulations are required to assure that lots and garages do not become eyesores. Other important considerations include the locations and widths of driveways and the ability of these facilities to receive and discharge their patrons without causing undue traffic congestion on the neighbouring streets. In addition, the public must be protected against unfair operating practices. Among several ordinance requirements should be the conspicuous posting of rate schedules at all off-street parking facilities available to the general public.

Many municipalities have found it advantageous to disassociate themselves from the operation of municipally-owned off-street parking facilities. The simplest means of achieving this is to lease the facility to a private operator. The city then assumes the functions of a landlord and leaves operation to the lessee, retaining control in widely varying degree.

If the local government desires to maintain a certain amount of control over the operation and still not assume the day-to-day functions of operation, the management contract or agreement is a logical tool. Through use of a management agreement, a municipality can retain control of rates, maintenance, promotion and other related items while full benefit is derived from the services of an experienced parking operator.

The method of payment stipulated in management agreements also varies widely. A common form specifies that the operator will receive a percentage of the gross revenue from parking. The City of Chicago has entered into numerous such agreements in its parking programme. Initially, the operators were paid a small percentage of gross revenue for management alone, and reimbursed directly for expenses of maintenance and operation. After use of the facilities stabilized, the city found it advantageous to increase the operator's percentage to an amount sufficient to cover both the management fee and expenses. The city was thereby relieved of the burdensome task of auditing the many separate items of expense which accrued each month.

Management agreements which stipulate a percentage of gross revenue to the operator in addition to reimbursement for expenses have been used with remarkable success. There is one serious drawback, however, to this type of agreement. It offers the operator very little incentive to reduce the operating expenses and thereby increase the return to the city. For this reason, the City of Cincinnati developed a unique arrangement involving both a management fee and incentive fee.

The Cincinnati agreements specify payment to the operator of a fixed annual amount for management services. These include supervision (except for the working manager of the garage), book-keeping, promotion and various items of insurance. The operator is also reimbursed for direct expenses and paid an additional incentive fee based on net revenue. The contract amounts have been adjusted, insofar as possible, so that the management fee covers only the operator's expense and overheads while his profit, if any, is a function of the incentive fee.

The method through which off-street parking facilities are operated will also depend on type of control. The trend toward automation in off-street parking facilities is being spurred on by rising labour costs. Only a decade ago almost all parking lots and garages were operated by the use of attendants. In recent years, however, most new garages have been designed for self-parking. It has usually been found that the savings in labour expenses more than offset the investment in additional floor space.

Increased use of self-parking has encouraged the development of numerous electronic devices including automatic ticket issuing machines; vehicle detection systems to actuate signs and control traffic within the garage; and a completely automatic cashiering system. The latter is in an advanced stage of development and should be available in the near future.

Parking meters installed at individual car spaces within a lot or garage have also been effectively used in municipal operation. These are particularly applicable in facilities with numerous entrances and exits which would each require an attendant or automatic device for satisfactory control.

Index to Vol. 2

The Index for Volume 2 was sent to subscribers with the June issue. A few copies are available for others on request.

INDUSTRIAL NEWS and INFORMATION

TRUSTING the motorist to pay his fee for using a car park owned by Cheltenham Corporation appears, after several months trial, to be meeting with success. A ticket issuing machine has been installed in the trial park and the motorists trusted to pay for their ticket—no attendants are on duty to collect money or check whether or not payment has been made at all. The Chairman of Cheltenham Corporation Highways Committee has stated that the costs related to the upkeep of this car park have gone down while the income from parking fees increased.

The machine in use in this trial is, in the majority of respects, identical to that used by British Railways for issuing platform tickets. The makers, National Automatic Machines Ltd., are at present contemplating the production of a similar machine but one which will print a date and time on the ticket, to enable it to be used for street parking schemes.

T.E.C. 214 for further details

The machine used in Cheltenham.

New Parking Manual

Venner Ltd., makers of the Park-o-Meter, have recently published a manual for use by traffic engineers and the authorities responsible for the planning of parking meter zones.

Set out in chronological order are the proved methods which ensure the smooth progression of events leading up to the application for an order, the preparation of material for the enquiry, the invitation to tender for the supply and maintenance of equipment and the installation and maintenance of meters.

T.E.C. 215 for further details

Please use the prepaid cards for the Reader Information Service. For further details of items mentioned in this journal, complete and return the card to us.

Austin-Western Crane

Jack Olding & Co. Ltd., announce the arrival of the first Austin-Western Model 210 Hydraulic Crane in the United Kingdom. With its all wheel steering and telescopic boom, which can swing in a continuous full circle, the 210 is an answer to tight, cramped working conditions and low overhead clearances. Mounted on rubber tyres, it has travel speeds of up to 19 m.p.h.

Among the many attachments available for this machine are: clamshell and orange peel buckets, electromagnets, maintenance platform, bulldozer blade, snow plough, mechanical winch, manual boom extensions and dual cable hoist.

T.E.C. 216 for further details

New Plant Hire Company

A new contractors' plant hire company, with depots at Harrow, Middlesex, and Barnsley in the West Riding of Yorkshire, has been formed under the chairmanship of Sir Maurice Adams, K.B.E. Head Office of the new company, registered as R. & M. Plant Ltd., is at Wealdstone.

The company's general manager, Roger H. Blackham, is a well known personality in the civil engineering and contractors' plant industry; he was previously London manager of Michigan (Great Britain) Ltd. and before that was with the George Cohen's Contractors' Plant Department and with Blaw Knox Ltd. Apart from the sale and hire of the complete range of contractors' plant, such as mobile cranes, compressors, dumpers, mixers, road making and all types of earth moving plant, the company will arrange the long term hire of large, specialist types of heavy equipment, including drilling rigs.

T.E.C. 217 for further details

Embedded Heating Cables

The 'Pamelec' Heating Division of British Insulated Callender's Cables Ltd. recently announced the introduction of their butyl rubber insulated, NBR compound sheathed, heating cables.

Because of their special construction these cables are eminently suitable for installation in roads, ramps, road bridges and similar situations for automatic de-icing and as an aid to snow clearing.

The cables are all of single-core construction comprising a stranded resistive wire element insulated with butyl rubber and sheathed with an NBR compound. These materials combine together to provide a cable which is mechanically tough, chemically inert, electrically safe and thermally stable under all conditions likely to be encountered, either during installation or in operation.

The cables are supplied in seven standard units having loadings of $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{2}$, 2, 3 and 4 kW rating on a 240 volt supply. They are provided with a 12 ft. long factory-jointed cold lead at each end, although longer cold leads can be provided to order. With the exception of the smallest unit all cables are loaded at approximately 5 watts/linear foot. Thus, for any given load per unit area, the spacing of the cables remains constant, irrespective of the units being employed.

To assist in installing the cables at their correct spacing, plastic spacer-bars similar to those used with terylene/glass roved PVC insulated heating cables are available.

As a result of the growing demand for 'Pamelec' electric floor-warming systems, and their widening field of application, BICC recently announced a general reduction in price and increase in range of heating cables.

T.E.C. 218 for further details

Chipping Spreader for Rollers

Aveling-Barford Ltd., have announced a new attachment for their tandem road rollers, designed for spreading precoated chippings on newly laid asphalt surfaces. The attachment appeared in public for the first time at the International Construction Equipment Exhibition at Crystal Palace, in June, front mounted to a TRV 5-8 ton tandem diesel roller. Development has been carried out in conjunction with Mr. R. G. Sparkes of Sparkes Bros. Ltd., who hold the patents. The Spreader will eliminate the laborious, inaccurate hand spreading of chippings that has been the only method available in the past. It comprises a two-ton capacity hopper, an hydraulic, motor driven, eight blade rotor to control discharge, an agitator to prevent solidification and a pump driven from the roller engine to operate the hydraulic motor. Rate of discharge is adjustable, by variable flow valve, between 80 and 150 sq. yds. per ton and, since the attachment is front mounted, the chippings are immediately rolled into the surface. The even spread ensured by mechanical discharge should provide more uniform, skid-resistant surfaces than hitherto.

T.E.C. 219 for further details

The Improved J.C.B.4

The makers, J. C. Bamford (Excavators Ltd. claim that 30 per cent greater output is obtainable with the improved J.C.B.4. The greater output is attributed principally to the new two lever valve block now being fitted. All rams operated by the two lever control are fully protected with pilot-operated auxiliary relief valves and the main circuit relief valve, which is also pilot-operated, is built into the block. The design of the valve is such that two or more plungers may be operated simultaneously to provide infinitely variable control of all four movements simultaneously. Integral check valves prevent oil feed-back between individual circuits.

A flow compensating valve is fitted to the boom section: this permits controlled high speed boom lowering at a speed greater than would normally be possible by the pump only. A proportion of the exhaust from the annular side of the boom ram is fed to the large side of the piston head to supplement the oil flow from the pump, thus increasing operating speed. Two lever control means that the operator does not have to release the levers during any part of the operating cycle. The jack ram, which is used for raising the machine to the working position, is operated by a separate and independent lever. The power unit is now fitted with a sintered bronze clutch plate and heavy duty clutch release bearing. The engine mounting brackets have been moved from the front of the unit to a mid-mounting pad, in order to facilitate engine removal. To provide a more responsive unit a mechanical governer has been fitted to the fuel pump. The addition of a six-plated pusher type fan draws hot air away from the operator and provides better cooling in tropical conditions. To provide even greater front-end stability, a solid cast iron axle, fitted further forward than previously, is now provided. Fenders have been reinforced and a heavier gauge plate is being used. A new type filter head, using a horizontal instead of vertical relief valve, is now provided and wheel centres have been strengthened by the addition of welded-in gussets. An entirely new and more robust dipper arm construction, using a fabricated box section in place of pressings, is now being employed. The lower part of the 'A' frame, the slewing carriage and slewing thrust rail have all been redesigned and enlarged in section where necessary and an additional bearing has been added to the top of the king post to further strengthen this part of the machine.

T.E.C. 220 for further details

The J.C.B.4 in its new form.

The Econ Beacon

The Econ traffic beacon has been designed to comply with the Traffic Signs Regulations—Statutory Instruments No. 13/1957, para. 24 and the Traffic Signs (Amendment) Regulations—Statutory Instruments No. 1095/1960 para. 2 (9). These Statutory Instruments permit the use of flashing red signs in conjunction with temporary road signs, to convey to drivers of vehicles that special care is necessary.

In designing the Econ traffic beacon, every effort has been made to make theft and malicious damage as difficult as possible, even the operating switch is concealed and can be held secure behind a locked bolt to prevent interference. The beacon consists of a lens, surmounting an electronic switch and a battery which are housed in a section of 1¼ in. steel tube. This tube can be secured, by all types of scaffold fittings, to tubular steel scaffolding and by means of pipe saddles or clips to wooden boards. Alternatively the beacon can be screwed into an additional length of pipe and embedded in a solid block of concrete or in the ground. The bulb, switch and battery are sealed into the pipe and are weatherproof. The operating mechanism consists of an electronic switch comprising transistors, capacitors and resistances operated from a six volt battery. There are no moving parts and there is no interference with radio or television transmissions. The lens are of 5 in. diameter and the rate of flashing is 60 per minute, with a dark period of just under six-tenths of a second. If switched on and left running continuously day and night without attention, the life of the battery is just over one month, but if the lamp is turned off during the hours of daylight, the life of the battery will be extended to approximately 10 weeks.

T.E.C. 221 for further details

Mercury Lamp Price Changes

Philips Electrical Ltd. announce that from June 15 price changes affecting colour corrected mercury fluorescent lamps, including types with internal reflectors and normal mercury lamps, have come into effect. Considerable reductions in the prices of the MBF/U and MBFR/U types are made. Increases of about 6 per cent are operative on the MB/U range with the exception of the 1,000 W. rating which remains as before. The price changes mean that for the first time the 80 and 125 W. colour corrected versions are the same price as the equivalent MB/U lamps.

T.E.C. 222 for further details

Survey of Jamaica

Hunting Surveys, Ltd., London, have been awarded a contract to photograph the whole island of Jamaica from the air under a recently announced Colonial Development and Welfare Scheme to assist the Jamaican Government.

The 4,411 square miles of the island will be photographed at 1/25.000 scale by an aircraft of Hunting's Canadian associates.

T.E.C. 223 for further details

Please use the prepaid cards for the Reader Information Service. For further details of items mentioned in this journal, complete and return the card to us.

BACK NUMBERS

Requests are frequently received for back issues of *Traffic Engineering & Control*, and because of expense involved, including search, packing and dispatch, it has been decided to charge 5s. for 1960 numbers and 4s. for those of 1961. This does not apply to retrospective subscribers for the current year.

The May and December 1960 issues are out of print and if any readers have got spare copies it would be appreciated if they could return them to Printerhall Ltd., 34/40 Ludgate Hill, London, E.C.4.

STOP parking control problems with

PARCOA

AUTOMATIC PARKING SYSTEMS

PARCOA automatic parking systems provide the complete mechanical answer to trouble-free control. This well-proven system can be relied on to handle traffic smoothly, safely, efficiently and economically in *any* parking facility.

THE MAIN ADVANTAGES

CUTS OPERATING COSTS. Eliminates Payroll Expense, Shift Working and Revenue Losses. Avoids problems of labour procurement and supervision. Amortised over a few years—costs much less than labour.

CONTROLLED CAPACITY. With PARCOA there can be no over-crowding. No customers looking for spaces that are not there.

FLEXIBLE OPERATION. Your choice of exclusive card-keys, coins, tokens, automatic ticket-dispensers or any combination to fit your specific needs.

PROTECTS REVENUE. Assures 100% collection, and includes self-locking cash vault with four-way lock.

PARCOA—THE RIGHT CONTROL FOR YOUR PARTICULAR NEED . . .

Your enquiries are invited. Our advisory service can help you through all the stages of developing efficient, smooth running and economically sound off-street parking arrangements.

Exclusive U.K. Distributors

PARKING DEVELOPMENTS LIMITED

2-4 CRANMER ROAD, LONDON, S.W.9. *Tel. RELiance 5192*

CONCRETE ROADS

CAUTION ROAD UNDER REPAIR

Are you interested in saving at least 25% of the cost?

Send for important information on

The METTEXTURE PROCESS

—the patented mechanical method of hacking old and damaged concrete to a precise depth, and providing an evenly keyed sub surface to receive new topping.

Trained operators and equipment supplied in any locality.

ESTIMATES FREE

The Mettexture Service

The METROPOLITAN CONSTRUCTION CO. LTD.

Bow Bells House, Bread St. (Cheapside), London, E.C.4. **City 1488**

Traffic Engineers !

The all-important TRAFFIC CENSUS can be readily obtained with a

SYX-RRL Vehicle Counter No. 4

Manufactured by :

W. R. SYKES INTERLOCKING SIGNAL CO. LTD.

Voltaire Road, Clapham, London, S.W.4

Sales & Service by :

S.G.E. SIGNALS LIMITED

East Lane, Wembley, Middlesex, England

Telephone: ARNold 4321